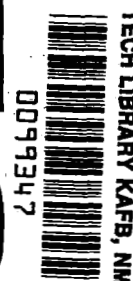


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NASA Metrology and Calibration - 1980



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*Proceedings of the Fourth Annual Workshop
held at NASA Langley Research Center
Hampton, Virginia
October 21-23, 1980*

NASA



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NASA Metrology and Calibration - 1980

Proceedings of the Fourth Annual Workshop
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National Aeronautics
and Space Administration

**Scientific and Technical
Information Office**

1981

PREFACE

The National Aeronautics and Space Administration Metrology and Calibration Workshop was organized in 1977 in response to General Accounting Office report B-160682, "Centralized Direction Needed for Calibration Program," dated June 13, 1977, and in response to two letters, one from the Honorable Adlai E. Stevenson, Chairman of the Subcommittee on Science, Technology and Space dated June 30, 1977, and the second from the Office of Management and Budget dated August 17, 1977. These letters requested an agency-wide review of the calibration program to ensure the effective and proper support of the technical programs and to determine whether there are any areas where greater economy and efficiency could be realized. This workshop was organized under the Reliability and Quality Assurance Division, Office of Chief Engineer, NASA Headquarters, and consists of one representative from each field center, NASA Headquarters, and the Jet Propulsion Laboratory. Since the proceedings of the first, second, and third workshops were not published, this is the first formal document describing the metrology and calibration activities of NASA. The activities of this workshop have resulted in (1) a unification of responsibilities and objectives through the development of an agency-wide management instruction, (2) the development of a document describing the detailed calibration capabilities of each center, (3) a format for participating in and contributing to the National Bureau of Standards' Precision Measurement and Test Equipment (PMTE) Project, and (4) an increase in the level of communication between center metrologists concerning management techniques, calibration techniques, hardware, automatic calibration system software, operating procedures, and problems.

The use of trade names in this publication does not constitute endorsement, either expressed or implied, by the National Aeronautics and Space Administration.

Frederick A. Kern
Langley Research Center

and

Harry Quong
NASA Headquarters

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*Slide presentation only.

AGENDA

FOURTH NASA METROLOGY AND CALIBRATION WORKSHOP

Langley Research Center

October 21-23, 1980

1. Review and Assessment of NASA Metrology and Calibration Activities - Harry Quong
2. Review of Center Audits by the Office of Inspector General - Harry Quong
3. Changes to MIL-STD-45662 - Jack Rivers
4. Review of NASA Equipment Management System (NEMS) - DanaLee Green/BEMS-5
5. Center Status
 - a) Ames Research Center - Pete Haro
 - b) Dryden Flight Research Center - Harry Curley
 - c) Goddard Space Flight Center - Walt Owens
 - d) Jet Propulsion Laboratory - Bob Martin
 - e) Johnson Space Center - Jerry Shows
 - f) Kennedy Space Center - John Riley
 - g) Langley Research Center - Fred Kern
 - h) Lewis Research Center - Basil Kluchnik
 - i) Marshall Space Flight Center - Gene Carpenter
 - j) National Space Technology Laboratories - Herman Watts
 - k) Wallops Flight Center - Dick Gladding
 - l) White Sands Test Facility - Grady McCright
6. NBS Calibration Services - Norm Belecki, NBS
7. NBS Calibration Services for NASA - Grady McCright
Roundtable discussion
8. NBS Precision Measuring and Test Equipment Project Reviews - Jack Vogt, NBS
9. The Instrument Loan Pool - Two Approaches
 - a) JPL - Bob Martin
 - b) LaRC - Earl German
10. Mobile Cart System for Instrument Verification
 - a) GSFC - Walt Owens
 - b) LaRC - Mallory James

- | | |
|--|--|
| 11. Review of Draft NMI 5330.9A | - Harry Quong |
| 12. Calibration Intervals for Standards - Is There a Need for NASA-Wide Uniformity | - Fred Kern Roundtable Discussion |
| 13. Status of Implementation of NASA-Wide Calibration Decals | - Harry Quong Roundtable Discussion |
| 14. NASA Calibration Capabilities Catalog - Procedure for Updating | - Fred Kern |
| 15. Center Status in Current Use of GIDEP | - Harry Quong Roundtable Discussion |
| 16. Development of Plans/Objectives for FY 81 | - Harry Quong Roundtable Discussion |
| 17. Selection of Workshop Officers | - Harry Quong Roundtable Discussion |
| 18. Discussion Session - Open to NASA representatives and selected attendees | - Harry Quong Roundtable Discussion |
| 19. Tour of Wyle Laboratories Calibration Facility | - H. E. Williams Wyle Labs |

PARTICIPANTS IN
FOURTH NASA METROLOGY AND CALIBRATION WORKSHOP

Langley Research Center

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SUMMARY OF THE FOURTH
NASA METROLOGY AND CALIBRATION WORKSHOP

Frederick A. Kern
Langley Research Center

The fourth NASA Metrology and Calibration Workshop was held at the Langley Research Center on October 21-23, 1980, with 42 participants from NASA Centers, NASA Headquarters, Jet Propulsion Laboratory, National Space Technology Laboratory, National Bureau of Standards, U. S. Navy, U. S. Army and four of NASA's calibration service contractors. William B. Jones, Acting Chief of the Instrument Research Division, provided the opening remarks.

Harry Quong, NASA Headquarters, gave a review and assessment of the NASA metrology and calibration activities. He reviewed activities accomplished to date including: issuing NASA Management Instruction 5330.9, the establishment and continuance of the Metrology and Calibration Workshop, completion of the center surveys on metrology and calibration, inspection by the Office of Inspector General of four NASA centers, increased communication between centers, increased participation in National Conference of Standards Laboratories, and developing a closer working relationship with the National Bureau of Standards. He noted recommendations including: increase in interchange of calibration information, increase in standardization and coordination, and resolution of common issues such as calibration techniques, determination of time to calibrate instruments, and techniques for determining effective calibration intervals.

Harry Quong also presented a review of the results of center audits by the Office of Inspector General. Three centers, Marshall Space Flight Center, Langley Research Center and the Johnson Space Center, were audited. In general, the audits were favorable with few negative findings cited. The primary concerns expressed by the Office of Inspector General were that each center must maintain an updated calibration precision measuring and test equipment (PMTE) recall system and that techniques to assure uncalibrated instruments are used in accordance with NMI 5330.9 should be developed. The Metrology and Calibration Laboratories were being operated in a satisfactory manner.

Jack Rivers, representative of U. S. Army DARCOM Headquarters, reviewed the current status of MIL-STD-45662. The review covered requirements for establishing and maintaining a contractor calibration system for measurement and test equipment used in DOD contracts. The change which could have the greatest effect dealt with out-of-tolerance evaluators and techniques for analysis of impact of out-of-tolerance measuring and test equipment (M&TE) on product quality. One other change in M&TE control allowed the use of automated or manual techniques to indicate calibration status instead of using a sticker system. Mr. Rivers also noted that MIL-Handbook 52 is under revision with an expected publishing date of January 1981. Handbook 52 is not a contractual document.

Norm Belecki reviewed the National Bureau of Standards Calibration Services. Two activities were noted as overall goals of their program. These are (1) continual quantification of random measurement error and predictable instrument behavior at the measurement site through the use of check standards, control charts, redundant data and statistical analysis and (2) periodic determination of systematic errors, use of Measurement Assurance Program (MAP) services and use of NBS calibration services using NASA transport standards which NASA classifies as Reference Standards. Mr. Belecki recommended the increased use of control charts to reduce the need of NBS calibration services. Additionally NASA can help the MAP services by defining accuracy requirements, processing part of the data and providing transport standards. Belecki also proposed two questions for the workshop to consider. Can NASA form its own MAP program for the volt and can we devise a program using rotating check standards with $n+1$ standards where n is the number of participating centers? For both of these cases, NASA would have to analyze its own data.

Danalee Green, NASA Headquarters, reviewed the current work on the proposed NASA Equipment Management System (NEMS). Her presentation included the development history from 1972 to November 1980. Three system approaches were considered for a centralized control system, centralized, distributed and centralized-distributed. The centralized system was selected because it was the least costly and required no new computer procurements. In addition to the normal equipment management functions, the area of calibration was included for use in standards control and recall to provide for quality assurance of the calibration hardware. The projected method of implementing the NEMS system is one center at a time with Headquarters responsible for the operational system and each installation responsible for equipment management and their portion of the NEMS data base. She provided the workshop with a list of planning steps for utilizing the NEMS for calibration plus a listing of applicable core data elements. She requested a response from the workshop for five questions in three months and a finalization of calibration requirements within six months.

Grady McCright of the NASA White Sands Test Facility gave a presentation on the NBS calibration services used by NASA. He covered NBS-NASA personal contacts, use of NBS designed unique test equipment and NBS measurement assurance programs. He noted problem areas including NBS reorganizations and cutbacks, discontinued services and slow response in the data turnaround time. He recommended that NASA Headquarters provide additional funds for NBS to continue services, that NASA centers should purchase self-calibrating models wherever possible, and NASA centers should use other government laboratories wherever possible. The discussion following this presentation pointed out that NBS has formed a division chief level task force to define what is an outstanding calibration service which is to complete its job very soon. NBS uses about 2 - 3% of its budget for calibration services. Jack Vogt also noted that Harry Quong's letter concerning NASA calibration problems was very important to NBS in their effort to evaluate their calibration services.

Peter Haro, Ames Research Center, reviewed their activities for the past year. He noted they have started cycling new instrumentation through the calibration laboratory for acceptance testing and that their instrument recall/calibration system is fully operational with dimensional instruments being added into the program. ARC has rewritten AMM 5339.2 to be in agreement with NMI 5330.9. ARC has defined what it considers permissible inclusions, uncalibrated, and exception instruments in this instruction and sets out a method for determining recall periods. Future plans include purchase of equipment, establishment of full calibration requirements for the center, improvement of record keeping procedures and establishment of "metrology expert" services for users at the center.

Harry Curley of the Dryden Flight Research Center noted that the center was reorganized and as a result the calibration activity was identified as a facility which provides greater management exposure. He also noted the test equipment pool was transferred to the calibration facility and is operated by a contractor. The DFRRC recall program presently includes 1350 instruments.

Walter Owens, Goddard Space Flight Center, stated that the assured performance calibration (APC) system is being replaced by an automated calibration system using a programmable calculator as a system controller. In general, the GSFC operations remained constant compared to 1979.

Robert E. Martin, Jet Propulsion Laboratory, stated that the number of repair and calibration events remained constant since last year and the percentage of inventory on loan increased over ten percent. The number of new instruments purchased was 294. He also noted they had a formal release of section procedures and standards were labeled with NASA standard decals. Martin described their new frequency and time standard system using the Commodore PET as a controller. The JPL problem areas are parts delivery, response time of off-lab service to perform on-lab repairs, and non-availability of parts and manuals for older equipment.

Jerry Shows, Johnson Space Center, stated they had undergone a reorganization and the calibration laboratory is now under the Safety, Reliability and Quality Assurance Office. Instrument repair functions have been combined with the calibration laboratory. The reorganization has increased their scope of work and the Manned Spacecraft Calibration Laboratory (MSCL) operating and equipment budgets are now reviewed at director level. The MSCL manpower was reduced by one engineer since FY 80 and the support service contractor has added six people. Shows stated that the average turnaround time for instrument calibration and repair is about 8.7 days. JSC has MAP activity in the areas of the volt, resistance, capacitance, mass, ratio and microwave power.

John Riley, Kennedy Space Center, noted that calibration is performed according to user needs, reliability and quality assurance specifications or safety requirements. He said that KSC purges its recall program of inactive instruments after 24 months. The system presently contains over 21,000 units. KSC has assigned Shuttle program calibration responsibility to first level operation and maintenance organizations where sufficient uncertainty ratios can

be maintained. Instruments which cannot be done at this level are submitted to the calibration laboratory. He also stated that automation of calibration facilities is being done on a station-by-station basis when technically and economically justified. There are no plans for a large scale automated calibration system.

Fred Kern, Langley Research Center, stated that the LaRC Volt MAP activity was completed and the measurement plan approved. LaRC had an internal audit of the calibration program with no significant deficiencies noted. The conversion of all calibration data files to the microfilm system was completed. Several new capabilities were developed including (1) linear expansion measurements under cryogenic environment, a 15.9 cm (6.25 in.) stroke shaker system, a mobile cart instrument verification system, a calculator based accelerometer calibration system, a load cell calibration data system, a liquid flow system for 0.18 to 41 L/sec (3 to 650 gal/min) flow. He noted that the LaRC recall system was put in operation in June of 1980 with 409 instruments. This system does not include contractor government furnished equipment. In general the calibration and repair workload remained fairly constant.

Basil Kluchnik, Lewis Research Center, reported that the instrument and repair functions have been contracted out. The successful bidding contractor was expected to be on board in November 1980. The instrument support services at LeRC had 25 civil servants this past year performing over 13,600 instrument actions. Approximately 6670 instruments were done using automatic test equipment. The primary automatic test equipment (ATE) was the Fluke Terminal 10 which Frank Dellatorre said was becoming productive and presently used a semi-skilled operator.

Gene Carpenter, Marshall Space Flight Center, stated his laboratory had performed over 8300 calibrations the past year. Of these 2136 were out of tolerance requiring adjustment, 888 were out of tolerance requiring repair, and 5185 were within tolerance. He stated that two engineering technicians received training in a digital electronics course and one engineer completed an HP programming course. The B&C Instrument Company of Huntsville is providing on-call/on-site repair service for the majority of the instrumentation. MSFC has completed development of an automatic pressure transducer calibration system using a calculator as the system controller. Data is also reduced and analyzed for flow and force calibrations using the calculator.

W. Meredith, National Space Technology Laboratories, stated they are performing nearly 18,000 calibration and repairs per year. There has been a decrease in the urgency of work due to Shuttle work decline. He expects a continued work load reduction. He also said the average turnaround is 3-4 weeks.

Dick Gladding, Wallops Flight Center, stated they had four civil servants and four contractors in the calibration repair area. He reported WFC does not send many standards to the NBS. WFC uses the facilities at LaRC, GSFC and manufacturers. WFC performs some calibration work for the National

Oceanographic and Atmospheric Administration and the Coast Guard on the Virginia eastern shore area. They have a calculator based system operational for testing microwave equipment to 23 GHz. Plans are underway to upgrade the electromagnetics laboratory.

Grady McCright, White Sands Test Facility, reported they had 12 technicians and 2 engineers on contract for calibration and repair work and only 1 civil servant. The past year 7181 instruments were calibrated and 1312 were repaired. He also noted that within twenty working days 64% of electrical calibrations are completed, 100% of physical standards are done and 100% of mechanical calibrations are done. WSTF has obtained video training tapes from the Army on transistor theory and scope and voltmeter calibrations. WSTF uses GIDEP and estimates a cost savings of \$7800 per year. They are in the process of setting up an automatic calibration system using a PET controller for oscilloscopes. They also have an ATE for pressure transducer calibration. WSTF has completed the Volt MAP. Problem areas noted were NASA decals, slow response from NBS, funding and manpower, walk in work requirements and parts delivery. Future work includes: expanded ATE for temperature, voltmeters and other electrical instruments; purchase of a laser interferometer for MAP on gage and angle blocks; and expanded training.

Jack Vogt and Kathryn Leedy, NBS, reviewed the activities of the PMTE Project. The number of participating organizations has increased the past year. Leedy reported that out of 52 respondents to interval determination, there were 20 different ideas. In general, they were to determine recall interval by serial number, model, class, entire population, arbitrary decision, no periodic intervals and no calibration. Results from the Raytheon study showed there were several types of calibration laboratories in use. They are the centralized type laboratory, the central laboratory with a satellite lab, a mobile truck system, mobile carts and the MAP concept. For the 21 laboratories surveyed, 18 had combinations of these types. The turnaround and calibration times for these labs were

| <u>LAB TYPE</u> | <u>TURNAROUND</u> | <u>CALIB. TIME</u> |
|--------------------|-------------------|--------------------|
| Central Lab | 16-17 days | 1 - 8 hours |
| Satellite Lab | 3-4 days | 1 - 8 hours |
| Mobile Truck | 3-4 days | 1 - 8 hours |
| Portable standards | < 1 day | 1 - 8 hours |
| Mobile Carts | < 1 day | 1 - 8 hours |
| MAP | < 1 day | 1 - 8 hours |
| Operator Calib. | < 1 day | 1 - 8 hours |
| Wire Transmission | < 1 day | 1 - 8 hours |

Vogt noted that several of the surveyed labs were using Calibrate Before Use and Limited Calibration stickers to help reduce calibration costs. From this study and other work, Vogt recommended the following:

Encourage use of in situ and inservice type calibrations.

Use a central loan pool.

- Use limited calibration if it suits the application.
- Eliminate non-essential calibrations.
- Develop an information system for ground level management.
- Develop standard terminology.

Vogt also challenged NASA with this question. How can NBS and PMTE best benefit NASA centers in the future?

Robert Martin, JPL, described the loan pool system at JPL. The loan pool at JPL was made mandatory in 1969. It consists of "general use type" instruments and the monthly rental charge is 2.5% of the acquisition cost. Instruments in the loan pool should not be part of a special purpose instrument, consumed in the test, permanently installed in a facility, under the responsibility of a contractor, extensively modified or a deliverable item. There are 5100 items in the inventory at a cost of \$8,400,000 with about 12-13 loans per day. The past year showed the inventory up slightly with a significant increase in the percent of inventory on loan. Nearly one-third of the loans are in the one to two month category. Trends noted by Martin were small evolutionary changes: instrument procurements for systems, increased unit costs and an increased user acceptance of the loan pool concept.

Earl German, LaRC, described the Langley loan pool system. This loan pool operates three types of loans: indefinite loans, scheduled loans for 90 calendar days, and short term loan for 20 work days. There are 1200 high use rate instruments in the scheduled and short term loan categories with about 3600 loans per year. The LaRC loan pool does not charge for instrument loans.

Mallory James, LaRC, described the mobile cart instrument verification system developed at Langley. In general, it is similar to the GSFC mobile system they have used for several years. This system uses several selected instruments as standards to verify instrument performance in the facility. Under this program, no instrument repairs are performed in the facility. Instruments which cannot be brought into specifications are tagged for shipment to the central calibration and repair facility. The system has been in operation for six months. The average verification time is approximately two hours per instrument. Presently the mobile cart system is not used full time due to manpower limitations. The results achieved so far have been satisfactory and plans are being evaluated for expanding this concept.

Walter Owens, GSFC, has been using the mobile cart technique for several years. They have recently redesigned and updated their mobile system. This new system has the capability to perform automatic calibrations under the control of a programmable calculator. Instruments for measurement of voltage, resistance, current, capacitance, inductance, radio frequency power and AM/FM phase modulation can be tested with this new system. Plans include adding capabilities for oscilloscopes and power supplies in the near future. Presently they have written 100 programs for testing a wide variety of

instruments. The printout generated when an instrument is tested includes identification of where the instrument failed to meet specifications to help reduce repair time when the instrument is sent to the central repair laboratory.

Fred Kern led a roundtable discussion on the revision of NMI 5330.9. Although the revised draft had been circulated to all centers earlier for comment, several additional objections were raised as to the wording. As a result, no progress was made toward approving the revision. Harry Quong will rework the draft for future consideration.

Fred Kern had surveyed all centers to develop a data base for evaluating recall intervals for Reference Standards. The data for the volt area showed that the eleven centers used three different manufacturer's volt standards with recall intervals varying from 12 to 60 months with the majority indicating an interval of 24 months. In the area of pressure, ten centers use dead weight testers from two manufacturers with intervals ranging from 12 to 120 months. Other measurement areas showed the same trends. The conclusion from this limited study indicated additional work needs to be done to understand each center's justification for the interval chosen to determine if intervals can be optimized on an agency wide basis. Additional data will be obtained for evaluation at the next workshop.

Harry Quong led a round table discussion concerning the use of the NASA calibration decals. Only three centers were using the decals accepted at an earlier workshop. Other centers were using the Reference, Transfer and Working Standard decals but had difficulty in using the Calibration and Not Calibrated decals. Objections were significant and a review of the decal format was requested.

Fred Kern distributed the NASA Calibration Capabilities Catalog and requested each center representative to provide updated capability data for inclusion in the catalog by January 1981. Completion of this catalog represented a significant milestone for the workshop.

Jerry Shows of JSC was elected as the vice-chairman of the NASA Metrology and Calibration Workshop for 1981, replacing Fred Kern of LaRC who served for two years.

Several action items were identified for the workshop. These items are:

| <u>Action Item</u> | <u>Assignee(s)</u> |
|---|--------------------|
| 1. Provide specific comments on Danalee Green's handout and general comments on information desired in NEMS | NASA Centers |
| 2. Develop a draft Rotating Check Standards Program and provide to all NASA Centers by 12/23/80 | John Riley/KSC |

3. Review draft of Rotating Check Standards Program and provide comments to John Riley, KSC by 1/23/81 NASA Centers
4. Review Raytheon Reports (to be provided by NBS) and provide comments to Harry Quong by 12/1/80 NASA Centers
5. Provide NASA Comments on Reytheon Reports to NBS (Jack Vogt) by 12/15/80 Harry Quong/HQs
6. Provide information to NASA Centers on NSTL Metrology Calibration videotapes W. Meridith/NSTL
7. Provide information on MICOM Metrology/Calibration videotapes to Harry Quong Kathy Leedy/NBS
8. Review NASA Calibration Capabilities Catalog and provide corrections/additions to Fred Kern/LaRC by 1/1/81 NASA Centers
9. Provide data/information on the revision of the NASA calibration decal to Harry Quong by 1/1/81 NASA Centers
10. Provide comments on draft of NMI 5330.9A to Harry Quong by 1/1/81 NASA Centers
11. Provide Automatic Calibration System (ACS) software data to W. Owens/GSFC by 1/1/81 NASA Centers
12. Colate and distribute ACS software information to NASA Centers by 3/1/81 W. Owen/GSFC
13. Investigate the possibility of providing DP funds to support NBS initiatives Harry Quong/HQs

REVIEW AND ASSESSMENT OF
NASA METROLOGY/CALIBRATION ACTIVITIES

Harry Quong
NASA Headquarters

REVIEW AND ASSESSMENT OF NASA METROLOGY/CALIBRATION ACTIVITIES

- o ISSUANCE OF NMI 5330.9
- o ANNUAL METROLOGY/CALIBRATION WORKSHOPS
- o NASA HQS R&QA SURVEYS ON METROLOGY/CALIBRATION COMPLETED
- o INSPECTOR GENERAL AUDITS AT FOUR NASA CENTERS
- o INCREASED COMMUNICATION
- o INCREASED NCSL PARTICIPATION
- o INCREASED GIDEP PARTICIPATION
- o CLOSER WORKING RELATIONSHIP WITH NBS

RECOMMENDATIONS

- o GREATER INTERCHANGE OF INFORMATION
- o MORE STANDARDIZATION/COORDINATION
- o RESOLUTION OF COMMON ISSUES
 - o CALIBRATION INTERVALS
 - o CALIBRATION TIME
 - o CALIBRATION TECHNIQUES

CONCLUSION

- o DEFINITE IMPROVEMENTS
IN METROLOGY/CALIBRATION
ACTIVITIES

- o ROOM FOR FURTHER
IMPROVEMENT

INSPECTOR GENERAL'S AUDITS
OF CALIBRATION PROCEDURES AND PRACTICES
AT JSC, MSFC, LaRC, AND KSC

Harry Quong
NASA Headquarters

RESULTS OF AUDIT - MSFC

STANDARDS AND CALIBRATION BRANCH PERFORMING
COMMENDABLY WITH LIMITED STAFF

PROBLEMS WITH ONE LABORATORY BUT RESOLVED

MSFC CALIBRATION ACTIVITIES MEET OMB CIRCULAR
A-76

DISPOSED EQUIPMENT ON CALIBRATION MASTER LIST

MANAGEMENT ATTENTION ON ITEMS PAST DUE FOR
CALIBRATION

RESULTS OF AUDIT - LaRC

CALIBRATION OF INSTRUMENTS GENERALLY BEING
ACCOMPLISHED IN A SATISFACTORY MANNER

NEED TO ESTABLISH A CENTRALIZED UNIFORM RECALL
SYSTEM FOR PERIODIC CALIBRATION OF STANDARDS FOR
VARIOUS INSTRUMENT AREAS PER NMI 5330.9

NEED IMPROVED PROCEDURES TO ENSURE SCHEDULED
CALIBRATION OF INSTRUMENTS ON DEVELOPMENT TESTS
WITH QA REQUIREMENTS

REVISE LMI 4200.1 REQUIRING DOCUMENTED PROPERTY
WALK-THROUGH INSPECTIONS

ESTABLISH POLICIES AND PROCEDURES ON THE MANAGEMENT
CONTROL OF TRANSACTIONS OF GFE INVOLVED IN
CALIBRATION ACTIVITIES

RESULTS OF AUDIT - KSC

CALIBRATION STANDARDS SECTION OPERATING IN A
SATISFACTORY MANNER

ESTABLISH ONE OFFICE WITH THE RESPONSIBILITY FOR
ESTABLISHING KSC-WIDE CALIBRATION GUIDELINES FOR
NASA AND ON-SITE CONTRACTORS

ESTABLISH ONE ORGANIZATION FOR ACCEPTANCE TESTS
AND CALIBRATION OF TRANSDUCERS

ESTABLISH POLICY ON CALIBRATION EQUIPMENT AND
FUNCTIONS WHICH CAN BE DUPLICATED BY ON-SITE
CONTRACTORS

INACTIVE AND SURPLUSED EQUIPMENT IN RECALL SYSTEM

DIFFICULTY IN OBTAINING REPAIR PARTS

CONCLUSION

MAINTAINING AN UPDATED RECALL SYSTEM
OTHER THAN STANDARDS

ASSURE UNCALIBRATED INSTRUMENTS ARE
USED IN ACCORDANCE TO NMI 5330.9

METROLOGY/CALIBRATION LABORATORIES
ARE OPERATING IN A SATISFACTORY MANNER

MIL-STD-45662

MILITARY STANDARD

CALIBRATION SYSTEMS REQUIREMENTS

Jack Rivers

U.S. Army DARCOM Headquarters

MIL-STD-45662
MILITARY STANDARD
CALIBRATION SYSTEMS REQUIREMENTS

TOPIC OUTLINE

- ◆ PURPOSE
- ◆ APPLICATION
- ◆ BACKGROUND
- ◆ REVISION
- ◆ COORDINATION
- ◆ STATUS
- ◆ MIL-HANDBOOK 52

PURPOSE:

- ◆ PROVIDES REQUIREMENTS FOR ESTABLISHING AND MAINTAINING CONTRACTOR CALIBRATION SYSTEM FOR M&TE USED IN DOD CONTRACTS.

APPLICATION:

- ◆ APPLIES TO ALL CONTRACTS WHICH REQUIRE CONTRACTOR TO MAINTAIN M&TE IN SUPPORT OF CONTRACT REQUIREMENTS.
- ◆ MIL-Q-9858
- ◆ MIL-I-45208

BACKGROUND

- ◆ MIL-C-45662A PUBLISHED IN FEBRUARY 1962.
- ◆ SEVERAL ATTEMPTS TO REVISE.
- ◆ MEASURE ASSURANCE PROGRAM.
- ◆ STAFFING DIFFICULTY.

REVISION OF MIL-C-45662A

- ◆ MINIMAL IMPACT.
- ◆ INCREASE CONTRACTOR FLEXIBILITY.
- ◆ REVISE ONLY AREAS REQUIRING CHANGE.
- ◆ ADDITIONAL REQUIREMENTS.

MIL-C-45662 REQUIREMENTS

- ◆ GENERAL
- ◆ DESCRIPTION (WRITTEN)
 - ADEQUACY OF STANDARDS
 - ENVIRONMENTAL CONTROLS
 - INTERVALS OF CALIBRATION ◇
 - CALIBRATION PROCEDURES ◇
- ◆ CALIBRATION SOURCES
 - DOMESTIC CONTRACTS ◇
 - FOREIGN CONTRACTS
- ◆ APPLICATION AND RECORDS ◇
 - CALIBRATION LABELLING ◇
 - CONTROL OF SUBCONTRACTOR CALIBRATION
- ◆ QA PROVISIONS ◇

ADDITIONAL REQUIREMENTS

- ◆ OUT OF TOLERANCE EVALUATORS
 - EVALUATION OF SUSPECT PRODUCT
 - EVALUATION OF CALIBRATION ACCURACY
- ◆ CALIBRATION STATUS
- ◆ STORAGE AND HANDLING

INTERVALS OF CALIBRATION

- ◆ CONTRACTOR ESTABLISHES A RECALL SYSTEM FOR STANDARDS AND M&TE WITHIN ESTABLISHED TIME OR INTERVAL LIMITS.

CALIBRATION PROCEDURES

- ◆ REQUIRES PROCEDURES TO SPECIFY ACCURACY OF M&TE BEING CALIBRATED AND THE ACCURACY OF THE STANDARDS USED.

DOMESTIC CONTRACTS

- ◆ EXPANDS REQUIREMENTS TO INCLUDE ALL STANDARDS.
- ◆ REQUIRES RECORDS TO INCLUDE CALIBRATION DATA: ITEM IDENTIFICATION, INTERVAL, DATE OF LAST CALIBRATION AND RESULTS OF OUT OF TOLERANCE CONDITIONS.

APPLICATION AND RECORDS

- RECORDS MUST INCLUDE IDENTIFICATION OF ITEM CALIBRATED AND CALIBRATION RESULTS OF OUT OF TOLERANCE CONDITIONS.

QA PROVISIONS

- ◆ REQUIRES CONTRACTOR'S GAGES AND M&TE BE AVAILABLE TO GOVERNMENT REPRESENTATIVE WHEN REQUIRED TO DETERMINE CONFORMANCE TO CONTRACT REQUIREMENTS.
- ◆ CONTRACTOR PERSONNEL WILL BE AVAILABLE FOR OPERATION OF M&TE FOR VERIFICATION OF THEIR ACCURACY AND CONDITION.

OUT OF TOLERANCE EVALUATORS (ADDED)

- ◆ EVALUATION OF SUSPECT PRODUCT
 - CONTRACTOR ESTABLISHES PROCEDURES FOR THE ANALYSIS OF IMPACT OF OUT OF TOLERANCE M&TE ON PRODUCT QUALITY.
 - CONTRACTOR DETERMINES IMPACT ON PRODUCT QUALITY AND INITIATES CORRECTIVE ACTION.
 - RECORD RESULTS OF ANALYSIS AND CORRECTIVE ACTION TAKEN.
- ◆ EVALUATION OF CALIBRATION ACCURACY
 - CONTRACTOR ESTABLISHES PROCEDURE TO EVALUATE ADEQUACY OF CALIBRATION SYSTEM BASED ON OUT OF TOLERANCE RATE.
 - PROCEDURE WILL INCLUDE PROVISIONS FOR INTERVAL ADJUSTMENT, EVALUATION OF M&TE ADEQUACY AND ADEQUACY OF CALIBRATION PROCEDURES.
 - CONTRACTOR MUST IDENTIFY AND PREVENT USE OF UNSATISFACTORY M&TE.

CALIBRATION STATUS (LABELLING)

- ◆ PERMITS AUTOMATED/MANUAL SYSTEM IN LIEU OF LABELLING.
- ◆ ALTERNATE SYSTEM MUST INDICATE DATE OF LAST CALIBRATION, WHO PERFORMED THE CALIBRATION AND DATE NEXT CALIBRATION IS DUE.
- ◆ LIMITED OR SPECIAL CALIBRATION STATUS MUST BE INDICATED ON INSTRUMENT.

STORAGE AND HANDLING (ADDED)

- ◆ M&TE MUST BE HANDLED, STORED AND TRANSPORTED IN A MANNER NOT ADVERSELY AFFECTING CALIBRATION OR CONDITION OF THE EQUIPMENT.

COORDINATION

- ◆ ARMY
- ◆ NAVY
- ◆ AIR FORCE
- ◆ DLA
- ◆ INDUSTRY

STATUS

- ◆ DATED 10 JUNE 1980

MIL-HANDBOOK 52

- ◆ UNDER REVISION.
- ◆ DOD STAFFING OCTOBER-NOVEMBER 1980.
- ◆ TARGET FOR PUBLISHING - JANUARY 1981.

NASA EQUIPMENT MANAGEMENT

SYSTEM - NEMS

Danalee Green
NASA Headquarters

NASA EQUIPMENT MANAGEMENT SYSTEM (NEMS)

BACKGROUND

| | |
|---|-------------------|
| 1. SUPPLY AND EQUIPMENT MANAGEMENT DIVISION | 1972 |
| 2. EQUIPMENT VISIBILITY SYSTEM DESIGNED | 1972-3 |
| 3. EQUIPMENT VISIBILITY SYSTEM INSTALLED | 1974-5 |
| 4. GAO REPORT | JANUARY 1976 |
| 5. STANDARD EQUIPMENT MANAGEMENT SYSTEM RECOMMENDED TO CODE N, TODD GROO | APRIL 1977 |
| 6. STANDARD EQUIPMENT MANAGEMENT SYSTEM DISCUSSED AT FUNCTIONAL CONFERENCE | OCTOBER 1977 |
| 7. CODE N FUNDS SCOPING STUDY | OCTOBER 1978 |
| 8. NEMS APPROACH GENERATED AT FUNCTIONAL CONFERENCE | OCTOBER 1978 |
| 9. SCOPING STUDY COMPLETE | APRIL 1979 |
| 10. NEMS CONCEPTUAL DESIGN COMMENCED | APRIL 1979 |
| 11. INSTALLATIONS NOTIFIED (DIRECTORS OF ADMINISTRATION) OF NEMS | JUNE 1979 |
| 12. CONCEPTUAL DESIGN REVIEW BY NASA KEY EQUIPMENT MANAGEMENT PERSONNEL | JULY 1980 |
| 13. NEMS CONCEPTUAL DESIGN REPORT COMPLETE | AUGUST 1980 |
| 14. NEMS CONCEPTUAL DESIGN REPORT FORMALLY COORDINATED WITH INSTALLATIONS THROUGH DIRECTORS AND INVOLVED HEADQUARTERS OFFICES | SEPT. - OCT. 1980 |
| 15. BRIEF CODE B ON RESULTS | NOVEMBER 1980 |

EXISTING EQUIPMENT MANAGEMENT SYSTEMS

- INSTALLATIONS DEVELOPED SYSTEMS WITH LOCAL ASSET AND OPERATING RESTRAINTS
- INSTALLATIONS DEVELOPED OWN PROCEDURES, FORMS, DATA ELEMENT INTERPRETATIONS, SOFTWARE/HARDWARE CONFIGURATION
- INSTALLATIONS USE SEPARATE SYSTEMS RESULTING IN REDUNDANCY, SUCH AS:
 - QUALITY ASSURANCE/CALIBRATION
 - VEHICLE MAINTENANCE AND MANAGEMENT
 - COMPUTER MANAGEMENT REPORTING
 - AIRCRAFT REPORTING

COMPARISONS OF EQUIPMENT MANAGEMENT SYSTEMS

| | <u>NEMS</u> | <u>ANC</u> | <u>DFMC</u> | <u>GSFC</u> | <u>JSC</u> | <u>KSC</u> | <u>LaRC</u> | <u>LeRC</u> | <u>NSFC</u> | <u>NSTL</u> | <u>WPC</u> | <u>HD/76 Operation</u> |
|--|-------------|--------------|---------------|-----------------------|----------------|---------------|------------------|-------------|-------------------------------|-------------|---------------|------------------------|
| <u>System Name & Capability</u> | <u>NEMS</u> | <u>PACER</u> | <u>RIPOFF</u> | <u>Capital Assets</u> | - | - | <u>PACER</u> | - | <u>Center Property System</u> | <u>CADE</u> | - | |
| On-line - Retrieval | Y | N | N | N | N | N | Y | N | Y | N | N | Y |
| - Update | Y | N | N | N | N | N | N | N | N | N | N | Y |
| On-line - ADMOC Reports | Y | N | N | N | N | N | Y | N | Y | N | N | Y |
| Automated Inventory | Y | N | N | N | N | N | N | N | N | N | N | N |
| Batch Update - Frequency | - | Monthly | Weekly | Daily | Weekly | Weekly | Monthly | Weekly | Weekly | 2 Weeks | Weekly | - |
| - Media | - | Cards | Cards | Key Tape | Key Tape/Cards | Cards | Key Tape/Cards | Cards | Key Tape | Cards | Cards | - |
| <u>Hardware Used</u> | IBM 3033 | IBM 360/67 | CDC 6600 | IBM 360/65 | UNIVAC 1100 | Honeywell 635 | CDC Omega 480-11 | UNIVAC 1100 | UNIVAC 1180 | UNIVAC 1108 | Honeywell 635 | IBM 370/158 |
| <u>Programming Language</u> | COBOL | COBOL | COBOL | COBOL | COBOL | COBOL | COBOL | COBOL | COBOL | COBOL | COBOL | COBOL |
| <u>Retrieval System</u> | S2000 | - | - | RAMIS II | - | - | ADABAS | - | MIRADS | - | - | S2000 |
| <u>EVS</u> | | | | | | | | | | | | |
| Performs the function of automated interfaces | Y | N | N | N | N | N | N | N | N | N | N | N |
| <u>Calibration/Maintenance/ADP Reporting/Aviation</u> | | | | | | | | | | | | |
| Performs the function of | Y | N | N | N | N | N | Maintenance Only | N | N | N | N | N |
| Interfaces with | N | N | N | N | N | N | N | N | N | N | N | N |
| <u>Fiscal System</u> | | | | | | | | | | | | |
| Automated Interface with | Y | N | N | Y(T) | Y(T) | Y | Y | Y(T) | Y | N | N | N |
| <u>Property Disposal</u> | | | | | | | | | | | | |
| Automated Interface with | Y | N | N | Y | N | N | N | N | Y(P) | N | N | N |
| Y = Yes N = No T = Tape to tape P = Partial | | | | | | | | | | | | |

NASA-WIDE IMPROVEMENT IN EQUIPMENT MANAGEMENT

- IMPROVEMENTS REVOLVE AROUND A COMMON AGENCY DATA SYSTEM.
- IMPROVEMENT MUST COME FROM AN EXTERNAL SOURCE.

STUDY FOR AN AGENCY-WIDE EQUIPMENT
MANAGEMENT SYSTEM

- INSTALLATIONS SUBMITTED CURRENT EQUIPMENT MANAGEMENT INFORMATION.
- VISITED GODDARD, LANGLEY, AND KENNEDY TO REVIEW EQUIPMENT MANAGEMENT OPERATIONS.
- ALSO VISITED MIT TO REVIEW AUTOMATED EQUIPMENT INVENTORY PROGRAM.
- MET WITH KEY NASA EQUIPMENT MANAGERS TO DISCUSS DRAFT CONCEPTUAL DESIGN REPORT
- AGREEMENT REACHED TO PURSUE A STANDARD SYSTEM.

THREE SYSTEM CONFIGURATIONS WERE CONSIDERED:

- CENTRALIZED
- DISTRIBUTED
- CENTRALIZED-DISTRIBUTED

CENTRALIZED SYSTEM WAS SELECTED:

- STANDARD SYSTEM
- NO NEW COMPUTER PROCUREMENTS
- LEAST COSTLY
- SOFTWARE AND IMPLEMENTATION FOR ONLY ONE COMPUTER

DESCRIPTION OF NEMS

- SIMPLIFY, STANDARDIZE, AND REDUCE COSTS
- IMPROVE UPON EVS FUNCTIONS
- PROVIDE ACCOUNTABILITY FOR ALL CONTROLLED EQUIPMENT
- STANDARD DATA FIELDS, PLUS SPACE FOR EACH INSTALLATION TO MAINTAIN DATA ELEMENTS FOR LOCAL PURPOSES
- NEMS-1 FORM TO FACILITATE ACTIONS INVOLVING EQUIPMENT
- PORTABLE OPTICAL SCANNING DEVICES FOR AUTOMATED INVENTORY TAKING

NASA Equipment Management System-I

(NEMS-1)

| | | | | | | |
|--|--|---|--|-----------------------------------|--|---------------------------------|
| Equipment Control Number 13AN | | Item Name 20AN | | | | Acquisition Method 2N |
| Custodial Account No. 6AN | Manufacturer's Model Number 20AN | | Manufacturer's Code 6AN | | Date Acquired 6N | |
| Sub-Custodian Assignment 20AN | | Manufacturer's Serial Number 20AN | | System Code A | Acquisition Document Control No. 6AN | |
| Location Zip Code 9N | Building 4AN | Room Local Code 6AN | Management Identification Code A | Federal Supply Class 4N | Transaction Reference No. 9N | |
| Status Code a. Assigned A | b. Date 6N | Loan/Lease Store Date 6N | Inventory Date 6N | Cost 9N | Cost Estimated A | |
| Condition a. Code 7AN | b. Date 6N | Loan/Lease/Store Expiration Date 6N | Calibration Due Date 6N | Calibration Date 6N | Other Govt Agency 7AN | |
| Available Date 4N | Maintenance Date 6N | Labor Cost 6N | Parts Cost 6N | Hazardous Equipment A | Unique Equipment Number 7AN | |
| Installation Information 40 AN | | | | | | |

ACTIONS

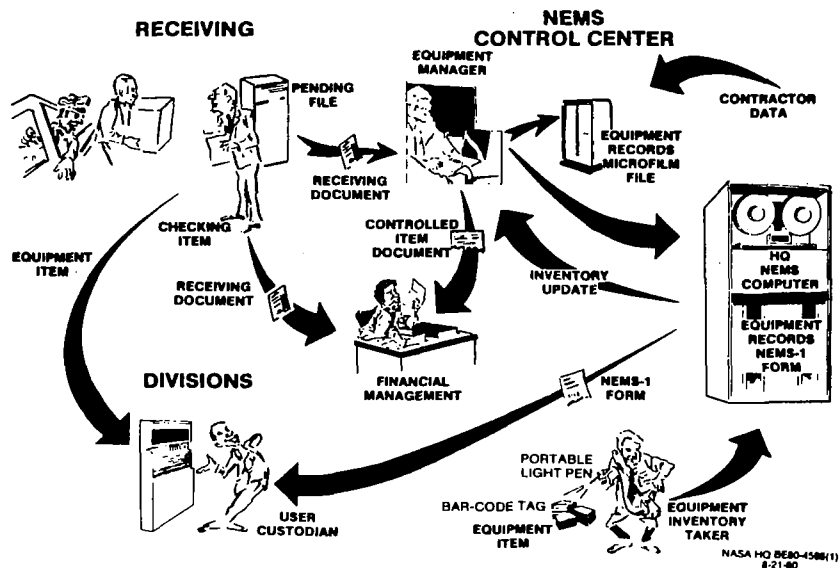
(CHECK ONE ONLY: If equipment is relinquished, obtain signature below)

- | | |
|---|--|
| <input type="checkbox"/> 42 Transfer to New Custodian Account Number <input type="checkbox"/> 40 Cost (Change) <input type="checkbox"/> 41 Location Change Within Custodial Account <input type="checkbox"/> 45 Available Date <input type="checkbox"/> 46 Loan/Lease/Storage Expiration Date <input type="checkbox"/> 47 Hazardous Equipment <input type="checkbox"/> 51 User Assignment (Sensitive Item) <input type="checkbox"/> 52 User Reassignment (Sensitive Item) <input type="checkbox"/> 54 Turn-in <input type="checkbox"/> 55 Loan-Out | <input type="checkbox"/> 56 Storage In <input type="checkbox"/> 59 Storage Out <input type="checkbox"/> 60 Calibration <input type="checkbox"/> 61 Repair Update <input type="checkbox"/> 60 Return of Leased Equipment <input type="checkbox"/> 61 Government Furnished Equipment <input type="checkbox"/> 62 Transfer to Other NASA Installation <input type="checkbox"/> 63 Transfer to Other Government Agency <input type="checkbox"/> 67 Return of Loan-In |
|---|--|

| | | | | | |
|----------------------------|-----------------------------------|------------|-----------|---------|---|
| F R O M | 13 PROPERTY CUSTODIAN'S SIGNATURE | 14 DATE | 15 WEIGHT | 16 CUBE | 23 TRANSPORTATION NEEDED <input type="checkbox"/> YES <input type="checkbox"/> NO |
| | 18 NAME | 19 TEL EXT | 26 BLDG | 27 RM | |
| T O | 22 SIGNATURE | 23 CODE | 24 DATE | | APPROVAL |
| | 25 NAME | 26 TEL EXT | 27 BLDG | 28 RM | |

Remarks

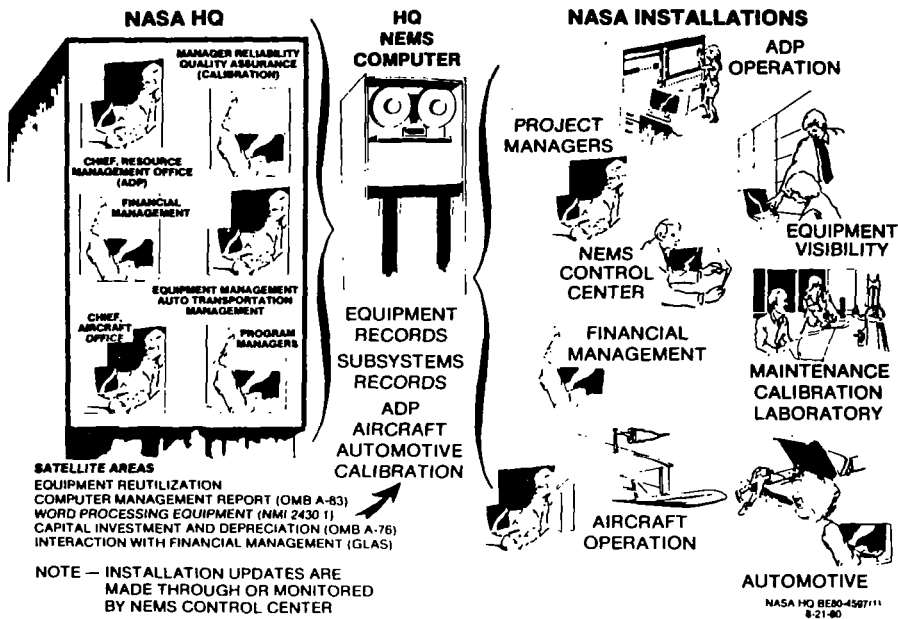
CONCEPT FOR NASA EQUIPMENT MANAGEMENT SYSTEM (NEMS)



NEMS ADDITIONAL KEY FEATURES

- INTEGRATE RELATED EQUIPMENT MANAGEMENT AND REPORTING FUNCTIONS:
 - ADPE
 - VEHICLES
 - AIRCRAFT
 - CALIBRATION
 - FINANCIAL RECONCILIATION
 - PROGRAM NEEDS
- TRANSACTION ORIENTED SYSTEM WITH:
 - INDEPENDENCE AND FLEXIBILITY FOR NON-ADP USERS
 - DIRECT ON-LINE ACCESS
 - EXPANDED EQUIPMENT DATA FOR LINE ORGANIZATIONS AND PROGRAM AND PROJECT PERSONNEL

PROJECT AND SUBSYSTEM MANAGERS HAVE ACCESS TO EQUIPMENT DATA



ESTIMATED COSTS

- FOUR-YEAR EFFORT WITH COSTS IDENTIFIED AS SYSTEM DEVELOPMENT/IMPLEMENTATION, EQUIPMENT PURCHASES, AND OPERATING COSTS
- SYSTEM DEVELOPMENT AND IMPLEMENTATION - \$1,150K
(FUNDED THROUGH THE OFFICE OF MANAGEMENT OPERATIONS)
- SYSTEM EQUIPMENT - \$713K
(FUNDED THROUGH THE OFFICE OF MANAGEMENT OPERATIONS)

DEVELOPMENT COSTS

- 40-50,000 LINES OF COBOL SOURCE CODE WILL BE REQUIRED

- MANPOWER SCHEDULE:

(COSTS IN FY 80 DOLLARS)

| | | | |
|-------|-----|------------------------------|-------------|
| FY 81 | 1 | CHIEF PROGRAMMER | 45K |
| | 5 | PROGRAMMERS (DEVELOPMENT) | 200K |
| | 2 | CLERICAL | 50K |
| | | | <u>295K</u> |
| FY 82 | 1 | CHIEF PROGRAMMER | 45K |
| | 5 | PROGRAMMERS (DEVELOPMENT) | 200K |
| | 2 | CLERICAL | 50K |
| | 1/2 | TRAINER | 20K |
| | | | <u>315K</u> |
| FY 83 | 1 | CHIEF PROGRAMMER | 45K |
| | 2 | PROGRAMMERS (IMPLEMENTATION) | 80K |
| | 2 | PROGRAMMERS (MAINTENANCE) | 80K |
| | 1 | CLERICAL | 25K |
| | 1 | TRAINER | 40K |
| | | | <u>270K</u> |
| FY 84 | 1 | CHIEF PROGRAMMER | 45K |
| | 2 | PROGRAMMERS (IMPLEMENTATION) | 80K |
| | 2 | PROGRAMMERS (MAINTENANCE) | 80K |
| | 1 | CLERICAL | 25K |
| | 1 | TRAINER | 40K |
| | | | <u>270K</u> |

EQUIPMENT COSTS

- COMMUNICATION MULTIPLEXER FOR HEADQUARTERS AND
APPROPRIATE SIZE MULTIPLEXERS FOR EACH INSTALLATION (11) .. 250K
- DATA TERMINALS (CRTs) (88)* 200K
- SERIAL/CHARACTER PRINTERS (50) 50K
- LINE PRINTERS (10) 50K
- COUPLERS/MODES FOR REMOTE TERMINALS (50) (PAIRS) 50K
- HAND-HELD, PORTABLE TERMINALS-WITH OPTICAL SCANNERS (25) .. 25K
- MICROFILMING/READING DEVICES (11) 88K

TOTAL 713K

*NOTE: THIS INCLUDES ONE SMART TERMINAL FOR EACH INSTALLATION.

ANNUAL OPERATING COSTS

- SYSTEM PROGRAMMER MAINTENANCE - \$720K
- COMMUNICATIONS - \$120K

(FUNDED THROUGH OFFICE OF MANAGEMENT OPERATIONS)

INSTALLATIONS' COSTS

- MAINTENANCE AND REPLACEMENT
- SUPPLIES AND MATERIALS
- ADMINISTRATIVE COSTS INVOLVED WITH CHANGEOVER
TO NEMS

COST/BENEFIT COMPARISON

A COST COMPARISON STUDY WAS PERFORMED ON THE PROPOSED NEMS VERSUS THE EXISTING SYSTEMS.

PRELIMINARY COST BENEFIT COMPARISON (\$1000)

| | <u>COST</u> | <u>SAVE/COST AVOID</u> |
|--------------------------------|-------------|------------------------|
| DEVELOPMENT AND IMPLEMENTATION | \$1,150 | -0- |
| EQUIPMENT ACQUISITION | <u>713</u> | -0- |
| | \$1,863 | |

| | <u>COST</u> | <u>SAVE</u> | <u>COST AVOID</u> |
|---|---------------|---------------|-------------------|
| OPERATION/MAINTENANCE | \$720 | \$700* | |
| COMMUNICATIONS | 120 | | |
| INCREASED REUTILIZATION OF CURRENT EVS POOL | | | \$600 |
| REUTILIZATION OF \$500-1,000 VALUE EQUIPMENT | <u> </u> | <u> </u> | <u>700</u> |
| | \$840 | \$700 | 1,300 |

NET BENEFIT: \$1,160

*Current Equipment Management ADP Systems
Costs as Reported by the Installations

NEMS MANAGEMENT BENEFITS

- PROVIDES AGENCY-WIDE INTEGRATED AND RESPONSIVE EQUIPMENT MANAGEMENT SYSTEM
- EQUIPMENT CONTROL AND ACCOUNTABILITY
- VISIBILITY FOR REUTILIZATION
- QUALITY ASSURANCE AND CALIBRATION RECORDS
- PERSONAL PROPERTY MAINTENANCE HISTORIES
- MOTOR VEHICLE HISTORIES AND REPORTS
- COMPUTER MANAGEMENT A-83 REPORTS
- AIRCRAFT HISTORIES AND MANAGEMENT REPORTS
- IMPROVES SUPPORT TO DIVISION CHIEFS AND PROPERTY CUSTODIANS

NEMS MANAGEMENT BENEFITS (Continued)

- REDUCES COST OF:
 - INVENTORIES
 - FORMS
 - REUTILIZATION
- PROVIDES SPECIAL APPLICATIONS FOR:
 - TRANSPORTATION
 - COMPUTER MANAGEMENT
 - PROGRAM AND RESOURCE MANAGERS
 - AIRCRAFT MANAGEMENT
 - QUALITY ASSURANCE AND CALIBRATION MANAGEMENT

IMPLEMENTATION

- FULL IMPLEMENTATION IN 48 MONTHS
 - FIRST 24 MONTHS - WRITING SPECIFICATIONS,
PROGRAMMING, AND TESTING
 - NEXT 24 MONTHS - TRAINING AND IMPLEMENTATION
AT EACH INSTALLATION

NEMS IMPLEMENTATION SCHEDULE
(AS OF AUGUST 1980)

FY 81-82

SPECIFY, PROGRAM, AND TEST (24 MONTHS)

FY 82

DEVELOP TRAINING PACKAGE (12 MONTHS)

FY 83

INSTALL NEMS (12 MONTHS)

HQ
LeRC
GSFC
WFC
LaRC

TRAIN DURING IMPLEMENTATION (9 MONTHS)

FY 84

INSTALL NEMS (12 MONTHS)

MSFC
KSC
JSC
NSTL
DFRC
ARC

TRAIN DURING IMPLEMENTATION (9 MONTHS)

THREE NEMS COMMITTEES

- HEADQUARTERS FUNCTIONAL STEERING GROUP
- HEADQUARTERS-FIELD INSTALLATION FUNCTIONAL STEERING GROUP
- SYSTEM CONFIGURATION CONTROL COMMITTEE

METHOD OF IMPLEMENTATION

- INSTALLED AT EACH INSTALLATION, ONE AT A TIME
- CURRENT INSTALLATION OPERATING SYSTEMS CONTINUE UNTIL NEMS IS COMPLETELY FUNCTIONAL.
- HEADQUARTERS RESPONSIBLE FOR A FULLY OPERATIONAL SYSTEM.
- INSTALLATIONS RESPONSIBLE FOR EQUIPMENT MANAGEMENT OPERATIONS AND THEIR PORTION OF THE NEMS DATA BASE.

NEMS WILL BE THE EQUIPMENT MANAGEMENT SYSTEM OF THE 1980'S.

PLANNING STEPS FOR CALIBRATION

1. REQUIREMENTS:

WHAT ARE THE REQUIREMENTS FOR CALIBRATION MANAGEMENT REPORTS?
(LIST REQUIREMENTS.)

2. DATA ELEMENTS:

WHAT ITEMS OF INFORMATION (DATA ELEMENTS) IN ADDITION TO THOSE ALREADY INCLUDED ARE NEEDED TO FULFILL THE REQUIREMENTS? (LIST THE DATA ELEMENTS.)

3. DEFINITIONS:

EACH DATA ELEMENT MUST BE DEFINED AND A STANDARD DEFINITION WRITTEN.

4. PROCESS FLOW:

WHAT ARE THE SOURCES (TRANSACTION DOCUMENTATION) FROM WHICH THE DATA ELEMENTS FLOW? LIST EACH ACTION WHICH CONTRIBUTES INFORMATION FOR ACCOMPLISHING THE REQUIREMENTS. DETERMINE HOW THE INFORMATION IS TO BE COLLECTED AND PROCESSED ON TO THE NEMS DATA BASE.

5. SOURCE DATA DOCUMENT:

DEVELOP AND DESIGN, AS NECESSARY, A MULTIPURPOSE STANDARD FORM OR FORMS FOR RECORDING DATA ELEMENTS WHICH CAN BE USED FOR ACCOMPLISHING CALIBRATION REQUIRED REPORTING AND ACTIVITIES.

APPLICABLE CORE DATA ELEMENTS FOR CALIBRATION

| | <u>DATA ELEMENT</u> | <u>DESCRIPTION</u> | <u>FIELD SIZE/TYPE</u> | <u>MANDATORY OR OPTIONAL</u> |
|------|-------------------------------------|---|----------------------------|----------------------------------|
| 28. | LABOR COST | FOR REPAIR/MAINTENANCE | 6N | 0 |
| 29. | LABOR COST ANNUAL | SYSTEM GENERATED | 6N | 0 |
| 30. | LABOR COST TO DATE | SYSTEM GENERATED | 7N | 0 |
| 31. | PARTS COST | FOR REPAIR/MAINTENANCE | 6N | 0 |
| 32. | PARTS COST ANNUAL | SYSTEM GENERATED | 6N | 0 |
| 33. | PARTS COST TO DATE | SYSTEM GENERATED | 7N | 0 |
| 34. | NUMBER OF MAINTENANCE ACTIONS | SYSTEM GENERATED | 2N | 0 |
| 35. | MAINTENANCE DATE | DATE OF LAST MAINTENANCE FORMAT - DDMMYY | 6N | 0 |
| 36. | CALIBRATION DATE | DATE OF LAST CALIBRATION FORMAT - DDMMYY | 6N | 0 |
| 36A. | CALIBRATION DUE DATE | DATE CALIBRATION DUE FORMAT - DDMMYY | 6N | 0 |

CALIBRATION COMMITMENT

- DRAFT OF 5 QUESTION RESPONSE WITHIN THREE MONTHS
- FINALIZATION OF CALIBRATION REQUIREMENTS WITHIN SIX MONTHS

AMES RESEARCH CENTER

STATUS

Peter J. Haro
Ames Research Center

Ames Research Center (ARC) has made numerous improvements in their Instrument Recall/Calibration System in FY 80. The most significant improvement is the evaluation and re-write of the Ames Management Manual (AMM) section 5339.2, Instrument Recall/Calibration System. The AMM has been revised and expanded to make clear the purpose of the system, make it applicable to Ames' tenants and on-site contractors as well as Ames' organizations; it sets out better definitions for instruments, makes inclusion of instruments in the system mandatory or permissible depending on use, and makes clear the responsibilities of RSE/Electronic Instrument Services Branch and other organizations at Ames Research Center in operating the system. It establishes the responsibility for compliance with the AMM at the organizational directors level. The revised AMM delegates the responsibility for labeling and identification of instrument status to the user and in addition it sets out the method for determining recall periods. This method is based on the type of instrument, the circumstances in which it is used and its calibration/repair history.

A pilot study was begun in August 1980 of four (4) Branches at Ames Research Center. This pilot study was determined to be necessary since Ames Research Center has basically five categories of instruments and only one category having an actual inventory list along with property numbers. It is possible that instruments under anyone of the five categories of instruments fall under the mandatory recall ruling (where research data are accuracy sensitive and/or instrument accuracy is essential for the safety of personnel) requiring them to be calibrated at fixed intervals. Those five categories are:

1. Instruments valued at \$500 or higher and/or classified as sensitive items which are inventoried and carried on the Property Management Branch property list
2. Instruments that at one time were inventoried and for some reason have been deleted from the property list
3. Instruments under \$500 and not classified as sensitive which are not carried on any property list
4. Instruments that belong to contractors/university workers at Ames Research Center and are not on a property list
5. Instruments developed in-house and are not on a property list

In order for Ames Research Center to have a complete capabilities catalog for our Instrument Recall/Calibration System it is necessary to have a list of all instruments; therefore, it is felt that a complete inventory/survey is necessary. But due to the unknown costs of such an undertaking it was felt that a pilot study will allow us to present Center management with a "ballpark" figure for such a task. The pilot study is expected to be completed in mid November 1980, and by the first part of 1981 (calendar year) an estimate of the cost for a Center wide inventory/survey is expected.

We have started cycling newly acquired instruments into the Instrument Recall/Calibration System. This part of the system has been functioning well but should be evaluated in the latter part of 1980 to determine if any changes are necessary.

The Ames Research Center Instrument Recall/Calibration System computer program is fully operational. We have the capability of updating the computer from a remote terminal in our office and providing recall lists monthly along with keeping track of hours for calibration/repair.

The final item in the way of improvements for Ames Research Center's Instrument Recall/Calibration System is the inclusion of dimensional instruments into our recall pool. This was started in June 1980 and is progressing well.

Improvement Plans for FY 81

Ames Research Center's plans for FY 81 include the purchase of some standards and test equipment, one of which is the purchase of a Fluke 5101B Calibrator. In the past the contract monitored by RSE was for Instrument Repair and Calibration and placed primary emphasis on the repair of instruments. Now with the additional responsibility of the Instrument Recall/Calibration System this increased workload on the contract makes it necessary for Ames Research Center and the contractor to expand and re-direct the overall efforts of this task. It has become necessary to increase the staffing of this contract with calibration type personnel along with the necessity for Ames Research Center to purchase the equipment necessary to operate a Metrology Laboratory.

If costs are not prohibitive a full Center wide inventory/survey should be started in FY 81. From this inventory/survey Ames Research Center can develop a calibration requirements "book" of the Center's needs and in turn more fully develop the Center's capabilities.

We plan on revising our record controls and our general record keeping and handling procedure. This will become necessary with the need for additional information required for establishing instrument recall intervals.

Additionally we will have our contractor provide the Center with a calibration metrology expert on an as-needed basis to help solve any and all calibration requirements of an unusual nature.

IMPROVEMENTS TO AMES RESEARCH CENTER INSTRUMENT RECALL/CALIBRATION SYSTEM FOR FY 80

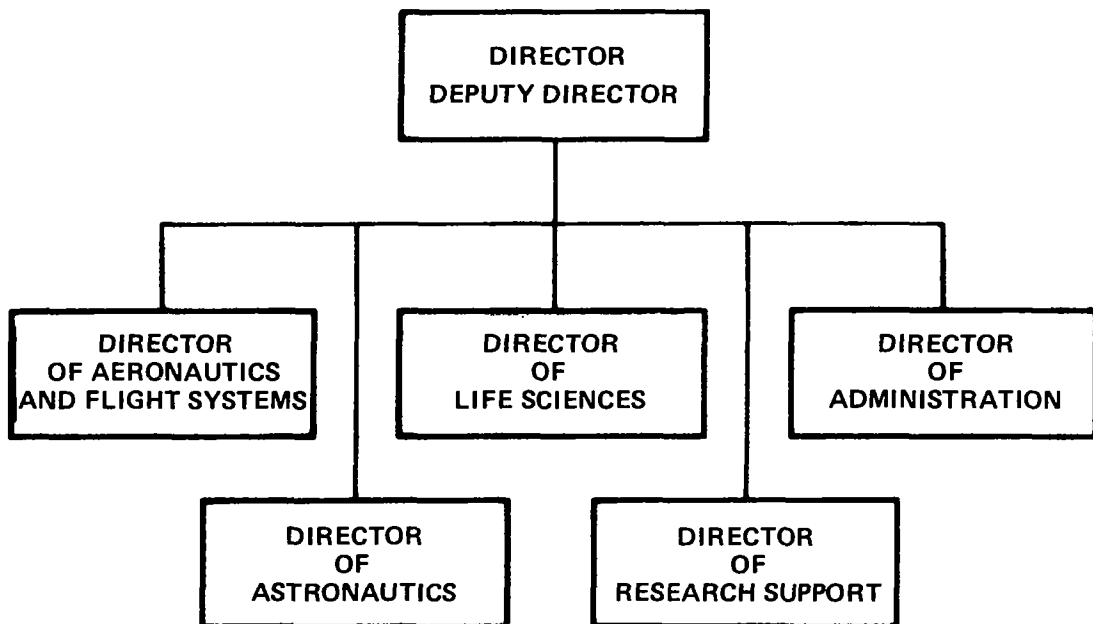
1. EVALUATE AND REWRITE OF AMM 5339.2, INSTRUMENT RECALL/
CALIBRATION SYSTEM
2. START (8/80) PILOT STUDY OF INSTRUMENT INVENTORY/SURVEY
3. STARTED CYCLING NEWLY ACQUIRED INSTRUMENTS INTO THE
INSTRUMENT RECALL/CALIBRATION SYSTEM FOR ACCEPTANCE/
INITIAL CALIBRATION
4. THE ARC COMPUTER PROGRAM FOR THE INSTRUMENT RECALL/
CALIBRATION SYSTEM IS FULLY OPERATIONAL
5. STARTED IMPLEMENTING DIMENSIONAL INSTRUMENTS INTO THE
INSTRUMENT RECALL/CALIBRATION SYSTEM

IMPROVEMENTS TO AMM 5339.2

1. ESTABLISHES THE RESPONSIBILITY FOR COMPLIANCE WITH THE
AMM AT THE ORGANIZATIONAL DIRECTORS' LEVEL
2. DEFINES "INSTRUMENTS" AND "CALIBRATION" AS PER
NMI 5330.9
3. DEFINES MANDATORY CALIBRATION REQUIREMENTS AS PER
NMI 5330.9
4. DEFINES WHAT IS CONSIDERED PERMISSIBLE INCLUSIONS,
UNCALIBRATED, AND EXCEPTION INSTRUMENTS
5. SETS OUT THE METHOD FOR DETERMINING RECALL PERIODS
6. DEFINES THE LABELING AND IDENTIFICATION OF INSTRUMENT
STATUS AND USER RESPONSIBILITIES

FUTURE PLANS FOR IMPROVEMENT

1. PURCHASE TEST EQUIPMENT AND SOME STANDARDS (ALSO AUTO TEST EQUIPMENT)
2. PROVIDE COSTS TO CENTER FOR A FULL INVENTORY/SURVEY OF INSTRUMENTS BASED ON PILOT STUDY
3. ESTABLISH FULL CALIBRATION REQUIREMENTS AT THE CENTER
4. DEVELOP CENTER CAPABILITIES TO MEET THESE REQUIREMENTS
5. IMPROVE RECORD KEEPING/HANDLING
6. ESTABLISH METROLOGY "EXPERT" SERVICES FOR USERS



DRYDEN FLIGHT RESEARCH CENTER

STATUS

Harry Curley
Dryden Flight Research Center

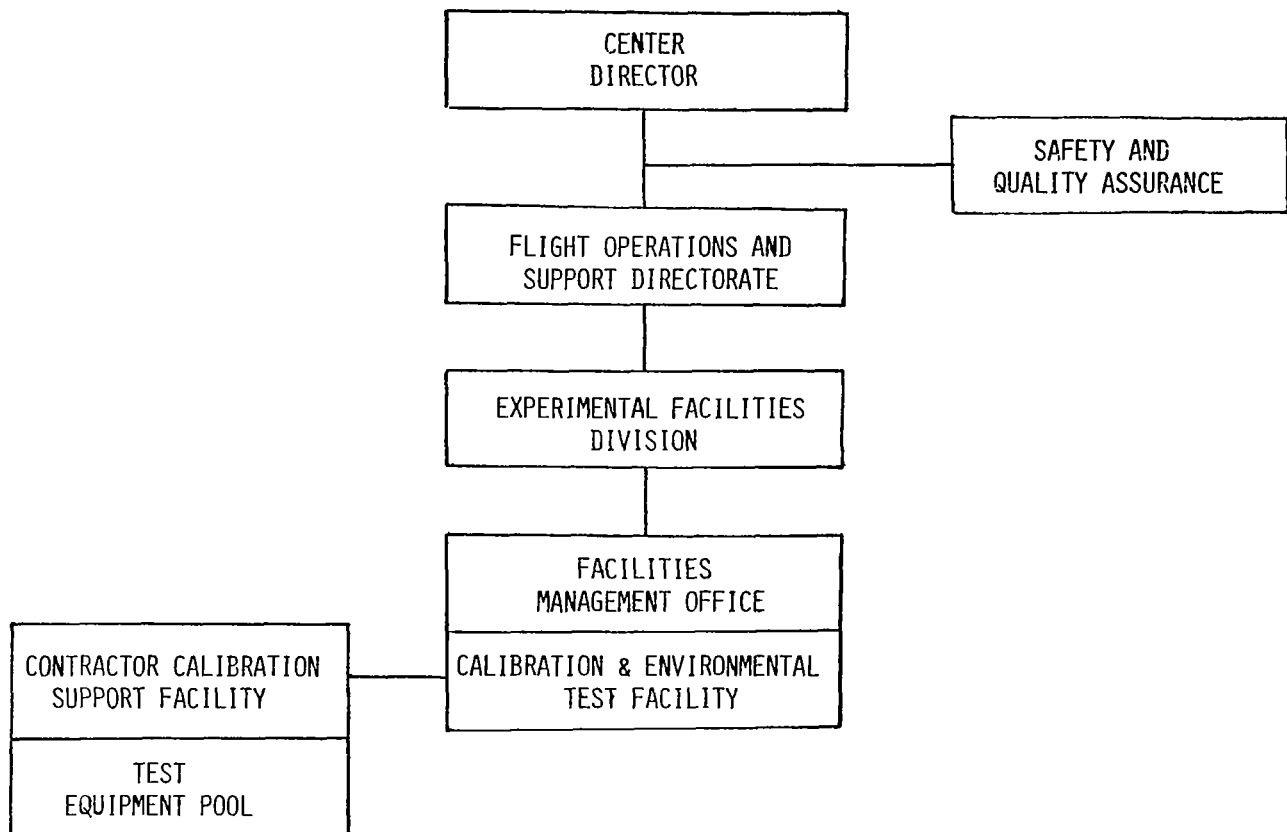
DRYDEN CALIBRATION FACILITY
CENTER REORGANIZATION BENEFITS

- CALIBRATION ACTIVITY IDENTIFIED AS FACILITY
 - GREATER EXPOSURE FOR CALIBRATION ACTIVITY
 - MONTHLY BRIEFINGS TO CENTER MANAGEMENT
 - ADVOCACY FOR CALIBRATION ACTIVITY
- CENTRALIZED CALIBRATION ACTIVITY AND PLANNING
 - FACILITY DEVELOPMENT PLAN
 - SIMPLIFIED POLICY CHANGES AND IMPLEMENTATION

DRYDEN CALIBRATION FACILITY
ACTIVITIES AND ACCOMPLISHMENTS

- FACILITY PLAN DEVELOPED
- TEST EQUIPMENT POOL OPERATION TRANSFERRED TO CALIBRATION FACILITY.
- TEST EQUIPMENT POOL INVENTORY REDUCED 220 ITEMS
- EXPANDED RECALL PROGRAM FOR STANDARDS AND SELECTED INSTRUMENTS
 - ADDED 25 TRANSFER AND WORKING STANDARDS
- RECALL PROGRAM PRESENTLY CONTAINS 1350 INSTRUMENTS
 - ADDED 130 ITEMS
 - DELETED 55 ITEMS

DRYDEN FLIGHT RESEARCH CENTER



GODDARD SPACE FLIGHT CENTER
STATUS

Walter L. Owens
Goddard Space Flight Center

The Test Equipment Maintenance and Repair Activity at the Goddard Space Flight Center continued at a slow pace in the number of instruments serviced during FY1980. In comparison to FY1979, the in-lab number of instruments increased by 338 items while the in-situ number of instruments decreased by 590 items. The included data indicate the activity in various categories. Changes in the activities occurred because of the changes in customers' needs since the workload is dependent upon instrument user initiation.

Our Assured Performance Calibration (APC) System is being replaced by the Automated Calibration System (ACS) in order to improve the in-situ calibration in the instrument users' laboratories. Frequency capability was added earlier this calendar year and the ACS was put into operation in July 1980. At present, the ACS replaces about 90% of the APC capabilities and this replacement should be completed during the next calendar year. Oscilloscope and power supply capabilities are to be added to complete the system. The Automated Calibration System name was chosen to emphasize calibration and eliminate the stigma of verification that had become associated with APC; the ACS is a calibration system with automated operation.

It has been a busy year with a lot of effort being spent on the Automated Calibration System (ACS) along with the normal activities. Kathy Leedy of NBS and Harry Quong of NASA Headquarters were given special but separate demonstrations of the ACS and their favorable comments are greatly appreciated.

A significant amount of time was spent this year in answering questions and discussing activities for the NBS Raytheon Contract on precision measuring and test equipment. If the results benefit the Government, the time will have been well spent.

GODDARD SPACE FLIGHT CENTER

TEST EQUIPMENT MAINTENANCE AND REPAIR ACTIVITY FY1980

| <u>Category</u> | | <u>Lab</u> | | <u>ACS/APC</u> | |
|-------------------------|------------|-------------|----------|----------------|--|
| Counters | 224 | 7.9% | 119 | 4.0% | |
| Scopes | 220 | 7.7% | 339 | 11.4% | |
| Plug-Ins | 285 | 10.0% | 707 | 23.8% | |
| Analyzers | 81 | 2.8% | - | - | |
| Amplifiers | 177 | 6.2% | 53 | 1.8% | |
| Bridges | 29 | 1.0% | 66 | 2.2% | |
| Power Supplies | 193 | 6.9% | 515 | 17.3% | |
| Recorders | 475 | 16.8% | - | - | |
| DVM/DMM | 165 | 5.9% | 240 | 8.1% | |
| AVM/VTVM | 102 | 3.7% | 219 | 7.4% | |
| Generators | 107 | 3.8% | 140 | 4.7% | |
| Meters | 122 | 4.4% | 312 | 10.5% | |
| Decades | 28 | 1.0% | 262 | 8.8% | |
| Miscellaneous | 73 | 2.5% | - | - | |
| Fire Alarm Transmitters | 204 | 7.3% | - | - | |
| Mechanical | 113 | 3.9% | - | - | |
| Standards | <u>232</u> | <u>8.2%</u> | <u>-</u> | <u>-</u> | |
| TOTAL | 2830 | 100% | 2972 | 100% | |

| <u>Category</u> | <u>Number of Items</u> | <u>Average hrs/Event</u> |
|------------------------|------------------------|--------------------------|
| Calibration Only | 1070 | 2.5 |
| Repair Only | 595 | 3.8 |
| Repair and Calibration | <u>1165</u> | 5.0 |
| TOTAL | 2830 | |
| ACS/APC | 2972 | 0.6 |
| GRAND TOTAL | 5802 | |

STATUS OF THE INSTRUMENT SERVICE

ACTIVITIES AT JPL

Robert E. Martin
Jet Propulsion Laboratory

AGENDA

- ACTIVITY LEVEL

- PROCEDURES UPDATE

- ADVANCES IN ATE

- PROBLEM AREAS

ACTIVITY LEVEL SUMMARY

| | <u>FY'78</u> | <u>FY'79</u> | <u>FY'80</u> |
|--|--------------|--------------|--------------|
| ● REPAIR AND CALIBRATION EVENTS | | | |
| ● LOAN POOL | 5564 | 6157 | 5971 |
| ● NON LOAN POOL | <u>2301</u> | <u>3019</u> | <u>3150</u> |
| TOTAL | 7865 | 9176 | 9121 |
| ● LOAN POOL | | | |
| ● AVERAGE NUMBER OF INSTRUMENTS ON LOAN | 2791 | 2684 | 3014 |
| ● % OF INVENTORY ON LOAN | 45 | 53 | 60 |
| ● NUMBER OF NEW INSTRUMENTS PURCHASED | 138 | 309 | 294 |

PROCEDURES UPDATE

- **FORMAL RELEASE OF SECTION PROCEDURES**
- **INSTRUMENT SERVICE STANDARDS LABELED
WITH NASA STANDARD DECALS**
- **CALIBRATION INTERVAL REVIEW AND
ADJUSTMENT**

ADVANCES IN ATE

- **FREQUENCY AND TIME STANDARD SYSTEM**
 - **COMMODORE PET PROVIDES TIME
INTERVAL MEASUREMENTS BETWEEN LOCAL
AND LOCAL/RECEIVED SIGNALS**
 - **SEQUENCE MANUALLY STARTED FOR SYSTEM
OPERATIONAL MONITORING (DAILY)**
 - **AUTOMATIC INITIATION AT PROGRAMMED
TIME TO PROVIDE DATA TO
U.S. NAVAL OBSERVATORY**
 - **INTERFACED WITH HP 9830A AUTOMATIC
CALIBRATION SYSTEM FOR FURTHER
PROCESSING AND REPORT GENERATION**

PROBLEM AREAS

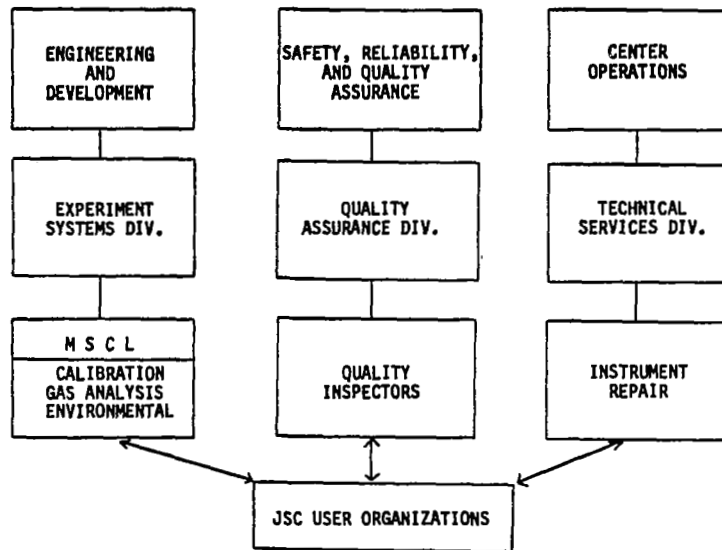
- **DELIVERY OF PARTS (TRANSFORMERS, MOTORS, ETC.)**
- **RESPONSE TIME OF OFF-LAB SERVICE PERSONNEL
TO PERFORM ON-LAB REPAIR**
- **NON-AVAILABILITY OF PARTS AND INSTRUCTION MANUALS
FOR OLDER EQUIPMENT**

JOHNSON SPACE CENTER

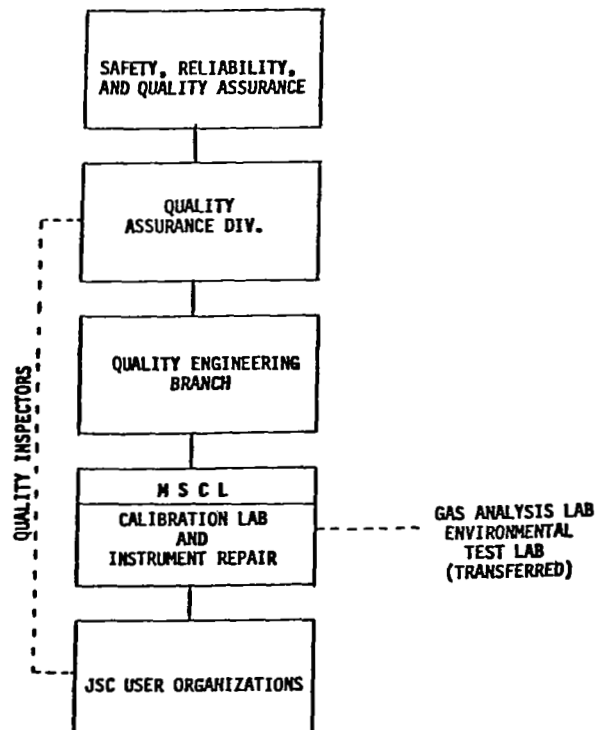
STATUS

Jerry Shows
Johnson Space Center

NASA - JSC
BEFORE JUNE 1, 1980



NASA - JSC
AFTER JUNE 1, 1980



MSCL POSTURE BEFORE JUNE 1, 1980

- GRADUAL REDUCTION IN SCOPE OF WORK
 - DUE TO SMALLER BUDGETS
 - DUE TO CUT IN LAB PERSONNEL
- INSTRUMENT REPAIR TIME IN CALIBRATION LABORATORY
 - 30 MINUTES FOR CUSTOMER'S INSTRUMENT
 - UP TO 2 HOURS FOR MSCL'S INSTRUMENT
 - PROMPTED BY REDUCED BUDGETS
- MSCL'S OPERATING AND EQUIPMENT BUDGETS WERE SUBMITTED AND REVIEWED AT THE DIVISION LEVEL.
- MSCL HAD NO EQUIPMENT BUDGETS FOR THE LAST HALF OF FY80.
- MSCL COULD PROCURE EQUIPMENT AND PARTS ONLY THROUGH SUPPORT CONTRACTOR UNDER WORK STOPPAGE CONDITIONS.

MSCL POSTURE AFTER JUNE 1, 1980

- INCREASED SCOPE OF WORK - GIVE FULL SERVICE TO USER ORGANIZATIONS.
- INCREASED INSTRUMENT REPAIR TIME IN CALIBRATION LABORATORY
- ADDED THE JSC INSTRUMENT REPAIR FUNCTION
 - DID NOT RECEIVE NASA PERSONNEL FORM TSD
 - FUNCTION IS BUDGETED COMPLETELY SEPARATE FROM CALIBRATION LABORATORY
 - FUNCTION CONSISTED OF 3 BPA CONTRACTORS
- MSCL'S OPERATING AND EQUIPMENT BUDGETS ARE NOW SUBMITTED AND REVIEWED AT THE DIRECTOR LEVEL.
- MSCL HAS RECEIVED COMPLETE SUPPORT THROUGH ALL OF S,R & QA -- WHICH HAS RESULTED IN AN INCREASE IN THE ENTHUSIASM OF ALL CONTRACTOR PERSONNEL.

MSCL MANPOWER FY80

NASA

1 SUPERVISOR
1 SECRETARY
3 ENGINEERS

LOCKHEED

1 SECTION SUPERVISOR
1 SECRETARY
2 LAB SUPERVISORS
3 ENGINEERS
14 TECHNICIANS
1 LIBRARIAN
2 CLERKS

MSCL MANPOWER FY 81

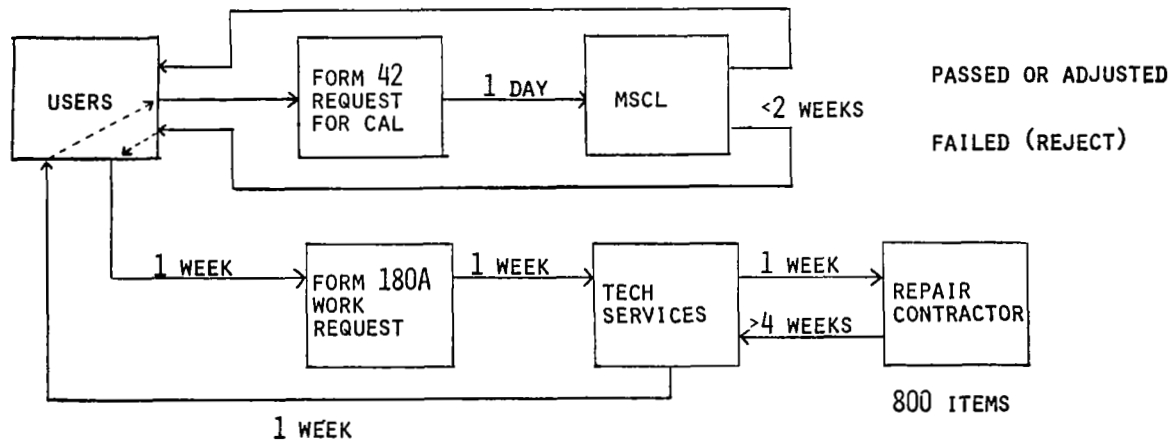
NASA

1 SUPERVISOR
1 SECRETARY
2 ENGINEERS

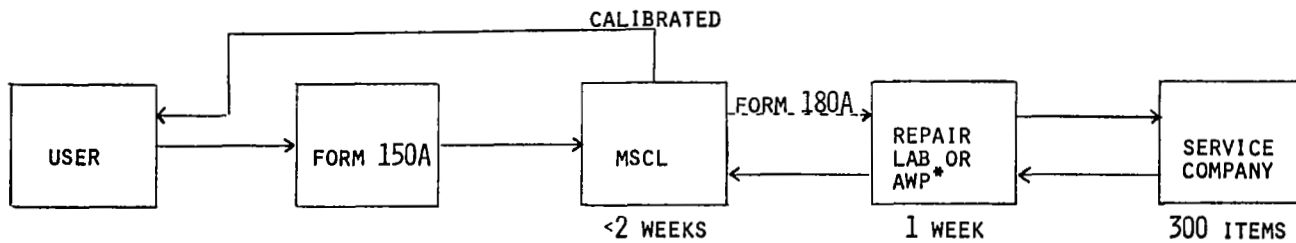
LOCKHEED

1 SECTION SUPERVISOR
1 SECRETARY
2 LAB SUPERVISORS
1 REPAIR ANALYST
3 ENGINEERS
18 TECHNICIANS
1 LIBRARIAN
2 CLERKS

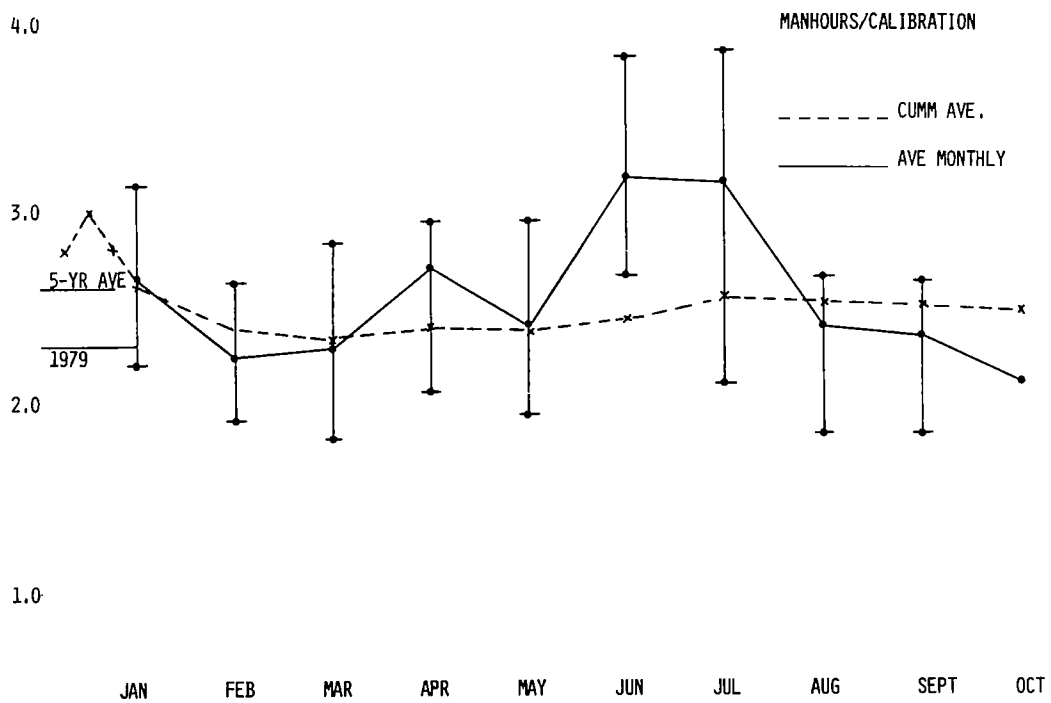
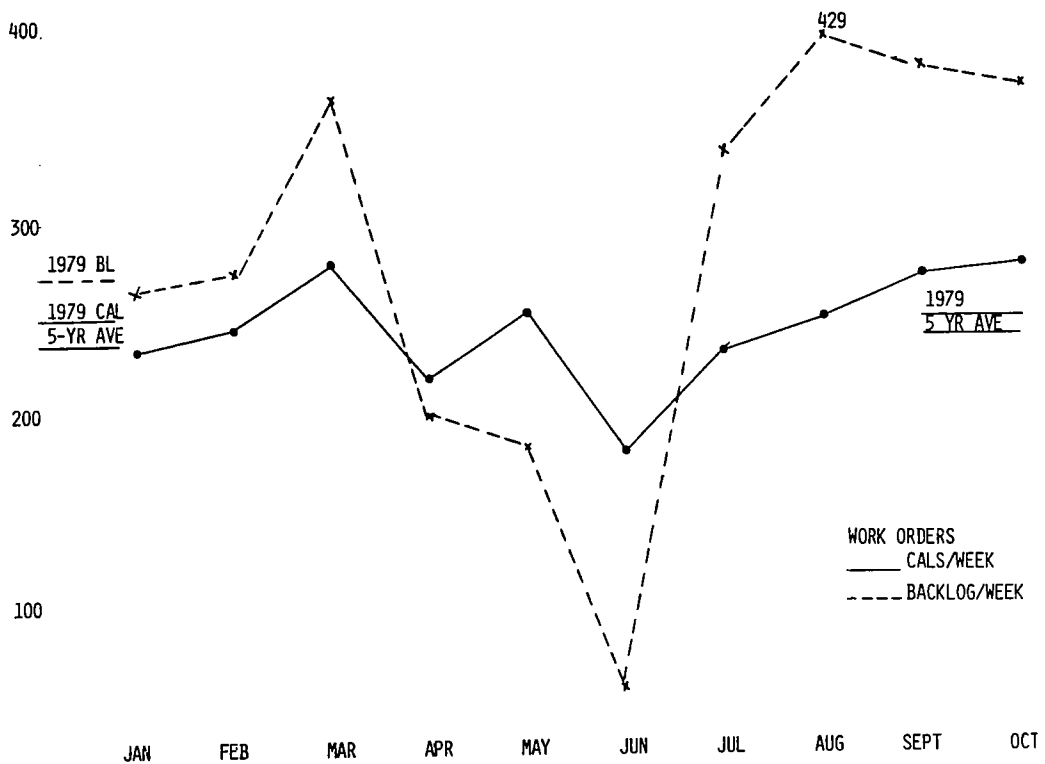
OLD SYSTEM

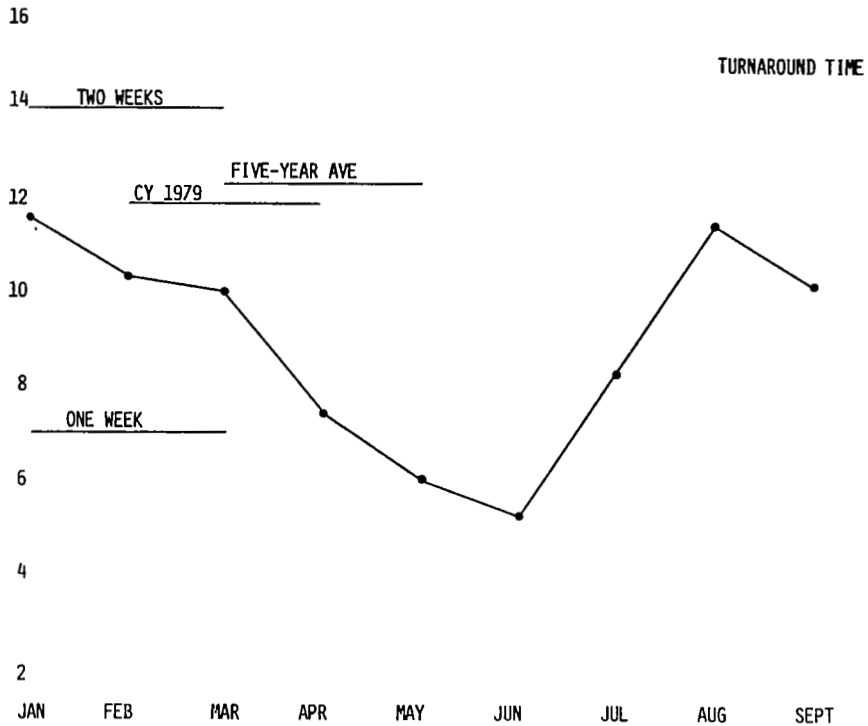


NEW SYSTEM



- O REPAIRED AT CAL LAB BENCH
- O AWAITING PARTS*
- O USER NOTIFIED





1980 MEAN TURNAROUND TIME
(CALENDAR DAYS)

| | |
|-----------|------|
| JANUARY | 9.5 |
| FEBRUARY | 10.3 |
| MARCH | 10.0 |
| APRIL | 7.4 |
| MAY | 6.0 |
| JUNE | 5.2 |
| JULY | 8.2 |
| AUGUST | 11.4 |
| SEPTEMBER | 10.1 |

YEARLY AVERAGE THROUGH SEPTEMBER 8.7

MEASUREMENT ASSURANCE PROGRAM CURRENT ACTIVITY

VOLTAGE - RESISTANCE - CAPACITANCE - MASS

MAP ACTIVITY RESULTS

- VOLT UNCERTAINTY 0.05 PPM
- OHM UNCERTAINTY 0.19 PPM
- CAPACITANCE 0.62 PPM
- MASS UNCERTAINTY 0.05 MG (0 TO 23 GRAMS)

ADDITIONAL MAP ACTIVITY

- | | |
|--------------------|----------------|
| 1. RATIO | 4. LENGTH |
| 2. MICROWAVE POWER | 5. TEMPERATURE |
| 3. RESISTANCE SET | 6. ATTENUATION |

CALIBRATION PROGRAM STATUS REPORT

OCTOBER 1980

JOHN P. RILEY
KENNEDY SPACE CENTER

SUMMARY

During the October 1979 to October 1980 time frame covered by this report, changes have been made in the KSC calibration program documentation, the assignment of calibration responsibilities, the calibration recall program data base, the calibration contract manning level, the size of the test equipment inventory supported by the calibration recall system, and the degree of automation of selected calibration stations.

CALIBRATION PROGRAM DOCUMENTATION

The Kennedy Management Instruction (KMI) which governs the KSC calibration program has been revised. Organization and document references have been updated, definitions added, and the criteria for determining calibration responsibility changed to reflect shuttle program operating guidelines. The KMI governing the operation of KSC test equipment loan pools which are operated by the Calibration Standards Section was rewritten to incorporate provisions for off-center loans, longer duration routine loans (up to 60 days) and 6 month program loans. More stringent requirements for controlling loan pool authorization cards and for reporting incidents of lost, stolen, or damaged test equipment were incorporated in the revision.

CALIBRATION RESPONSIBILITY ASSIGNMENT

This center has assigned shuttle program calibration responsibility to the first level operation and maintenance organizations. This approach reduces equipment downtime, and increases the use of limited and system calibrations.

The following general provisions of the KMI govern the assignment of calibration responsibilities:

"Test equipment will be calibrated to ensure performance consistent with instrument application and program/project operational and safety requirements. Article and material measurement processes require, as a minimum, a ten to one calibration ratio and calibration measurement processes require, as a minimum, a four to one calibration ratio.

(1). When the calibration ratio cannot be achieved because of equipment or state-of-the-art measurement limitations, the services of the next higher level calibration facility must be utilized or an authorization for exception obtained from the responsible NASA organization."

"Test equipment will be calibrated by organizations having first-level responsibility for operation and maintenance, when calibration can be performed to required accuracy levels using portable test equipment and working or system standards. When the accuracy, complexity, reliability of the units being tested, the unavailability of suitable working standards, inadequate environmental controls or extensive duplication of calibration facilities are factors, test equipment will be submitted for laboratory calibration."

CALIBRATION RECALL SYSTEM DATA BASE

Changes made in the calibration recall system program software have resulted in significant operating economies and permitted the retrieval of productivity and reliability data in more useable formats. The most significant change provides for retention in the data base of only the four most recent transactions for each unit of test equipment in the calibration recall system. Implementation of this change reduced the size of the data base by 65% (141102 data records were purged). The system currently contains 75258 data records on 21381 units of test equipment.

Software changes have been made which will provide a more useful data display format for analyzing and adjusting calibration intervals. The requirement for detailed information on calibration program resources used to support space transportation system line replaceable units (LRU's) and shop replaceable units (SRU's) has also been met through software changes which enable us to provide input for the Maintenance Management and Control System (MMACS).

TEST EQUIPMENT INVENTORY GROWTH

The number of instruments in the calibration recall system has increased from 16358 to 21381 since October 1, 1979. (There were approximately 2000 overage instruments deleted during the same time frame.) In order to accommodate the additional workload resulting from the increased instrument population the manning level authorized by the calibration services contract was increased from 65 to 69 slots. The use of overtime to a maximum of 10% was also authorized in a substantially successful attempt to meet a target two-week average turnaround time.

During the time period covered by this report the KSC calibration and standards laboratories performed 26581 calibration services, 4666 repair services and 4295 cleaning services.

AUTOMATION

The automation of calibration facilities is being accomplished on a station-by-station basis when technically and economically justified. The degree of automation varies with the application, from simple print-out capability on manually operated systems to completely automated calibration of programmable instruments on a system having programmable standards under the control of IEEE 488 bus compatible desktop computer/controllers. There are no plans to procure a large scale automated calibration system for the KSC calibration laboratories in the foreseeable future. However, all procurements for calibration laboratory test equipment and standards are reviewed to assure that IEEE 488 bus compatibility options are incorporated to achieve maximum capability for automating test stations in which such equipment is used.

REFERENCES

1. NHB 5300.4 (1D-2) "Safety, Reliability, Maintainability and Quality Provisions for the Space Shuttle Program," page 5-23 paragraph 1D507, sections 4 and 5.

LANGLEY RESEARCH CENTER

STATUS

Frederick A. Kern
Langley Research Center

CALIBRATION ACTIVITIES

- MAP FOR VOLT COMPLETED
- EQUIPMENT FOR RESISTANCE MAP BEING PURCHASED
- INTERNAL AUDIT OF CALIBRATION PROGRAM
- COMPLETED CONVERSION OF ALL CALIBRATION DATA FILES TO MICROFILM

CALIBRATION SYSTEMS

- CONTROLLED CLEARANCE PISTON GAGE - RANGE OF 34.5 kPa TO 6.9 MPa (5 TO 1000 psi)
- DEVELOPED SYSTEM TO MEASURE LINEAR EXPANSION OF MATERIALS UNDER CRYOGENIC ENVIRONMENT
- LONG STROKE SHAKER SYSTEM - 15.9 cm (6.25 in.) STROKE, F UP TO 100 Hz, 4g FOR 0.9 kg (2 lb)
- MOBILE CART INSTRUMENT VERIFICATION SYSTEM
- CALCULATOR BASED SYSTEM FOR ACCELEROMETER CALIBRATION
- DEVELOPED LOAN CELL CALIBRATION DATA SYSTEM - NCSL NEWSLETTER, VOL. 20, NO. 3, SEPT. 1980
- LIQUID FLOW CALIBRATION SYSTEM - RANGE OF 0.189 TO 41.01 L/s (3 TO 650 gal/min)
- COMPUTER CONTROLLED PRESSURE CALIBRATION STANDARD FOR WIND TUNNEL

INSTRUMENT RECALL SYSTEM

- IMPLEMENTED COMPUTERIZED SYSTEM JUNE 1980
- CONTAINS 409 INSTRUMENTS
 - 271 INVENTORIED INSTRUMENTS AT A COST OF \$1.1M
 - 138 NON-INVENTORIED INSTRUMENTS AT A COST OF \$0.1M
- CONTAINS BOTH WORKING STANDARDS AND SELECTED INSTRUMENTS
- PROGRAM DEVELOPED TO MERGE WITH PACER PROGRAM

LEWIS RESEARCH CENTER

STATUS

Basil Kluchnik
Lewis Research Center

LeRC

INSTRUMENT SUPPORT SERVICES

| <u>TYPE</u> | <u>CONTRACT</u> | <u>IN-HOUSE</u> | <u>TOTAL</u> |
|----------------------------|-----------------|-----------------|--------------|
| Repair | 925 | 2,938 | 3,863 |
| Recall | 13* | 384 | 397 |
| Inspection & Acceptance | | 9,376 | <u>9,376</u> |
| | | | 13,636 |

*NBS

INSPECTION & ACCEPTANCE

| <u>ATE</u> | <u>OTHER</u> | <u>TOTAL</u> |
|------------|--------------|--------------|
| 6,674 | 2,702 | 9,376 |

ATE

| | |
|----------------|-----------|
| Transducers | 4,937 |
| Meters | 857 |
| Oscilloscopes | 200 |
| Amplifiers | 660 |
| Counter Timers | <u>20</u> |
| | 6,674 |

MANPOWER DISTRIBUTION

| | |
|--------------------------------|----------|
| ATE - Electronic | 1 |
| Transducers | 2 |
| Contract Repair - Coordinator | 1 |
| Repair, Calibration-Inspection | 18 |
| Supervision | <u>3</u> |
| | 25 |

MARSHALL SPACE FLIGHT CENTER STATUS

Gene T. Carpenter
Marshall Space Flight Center

INTRODUCTION

The following brief update summarizes the FY80 metrology activities at the Marshall Space Flight Center.

PRODUCTION STATISTICS

The calibration/certification workload included 4,759 electrical instruments, 954 physical devices, and 2,599 dimensional items for a total of 8,312 calibrations. The condition of the instruments as they were received for service is listed below:

| | Electrical | Physical | Dimensional |
|----|------------|----------|-------------|
| Ø1 | 1572 | 528 | 36 |
| Ø2 | 849 | 36 | 3 |
| Ø3 | 2337 | 1933 | 915 |

- Ø1 - Out of tolerance requiring adjustment
- Ø2 - Out of tolerance requiring repair
- Ø3 - Within tolerance

PRIORITIES/EMERGENCIES

As a part of our cost effectiveness/value added effort, a record is kept of occurrences where, except for the services provided by the Calibration Lab., a program/project might have been negatively impacted. This year there were 1842 of these nonroutine instances. A few examples are listed below:

- a. The programmable dc voltage standards that are a part of the Center's 4,000 channel digital data acquisition system that is used for all Shuttle Structural Test Programs.

- b. Numerous electronic deflection indicators (EDI's) and accelerometers for the Space Shuttle Main Engine steerhorn/nozzle assembly dynamics tests.
- c. Special flowmeters for troubleshooting the nose cone flowrate purge system in the MPTA (Main Propulsion Test Article) at NSTL.
- d. Special current shunts that were required to set up a tungsten filament strip lamp that is used for calibration of pyrometers that are used in the materials processing in Space Drop Tube Experiment.
- e. A vibration system consisting of instrumentation and accelerometers used for testing the SSME cryogenic bearings and seals.
- f. Evaluation of low pressure flight transducers for the Solid Rocket Booster.
- g. Instrumentation for development and qualification of heater elements for the gradient furnace.

TRAINING

Two electrical engineering technicians completed a 40-hour digital electronics course taught by the University of Alabama in Huntsville.

One engineer completed a 24-hour course on application and programming of the Hewlett Packard Model 9825 desk-top computer.

CHANGES

Repair Service Contracts

The on-call/on-site repair service for Hewlett Packard and Tektronix instrumentation is now being provided by B&C Instrument Company of Huntsville. This service was previously provided by Hewlett Packard and Tektronix. The service has been expanded to include Fluke, Cimron, Dana, Balwin-Lima-Hamilton, Doric, and Data Precision.

Calibration Due Notices

In an effort to reduce computer time and reproduction costs, decision was made to send "Calibration Due Notices" to the organizational elements on a monthly rather than weekly basis. The change has been well received by using elements with no loss in response and participation.

IMPROVEMENTS

The Hewlett Packard Model 3052A data acquisition system, which uses the Model 9825 as the calculator/controller unit, has been adapted to operate, control, retrieve data and perform data reduction and presentation for the three pressure transducer calibration systems. These systems cover the ranges of pressures up to 689 kPa (100 psi), 3.4 MPa (500 psi), and 41.4 MPa (6,000 psi) and can accommodate up to 40 test articles.

The calculator has also been programmed for data reduction and data presentation, both tabulated and graphic, for all load cells and flowmeters calibrated with the following systems:

Flow - Calibrations can be performed utilizing liquid (H_2O) and gaseous (GN_2 , helium and air) mediums. The two liquid systems cover the range of 63 $\mu L/s$ to 189 L/s (0.001 to 3000 gal/min). The two gas systems, which utilize bell provers, cover a range of 16.67 $\mu L/s$ to 94.4 L/s (1 cm^3/min to 200 ft^3/min).

Force - Calibrations of force measuring instruments, such as load cells, can be performed in both tension and compression modes on the following machines:

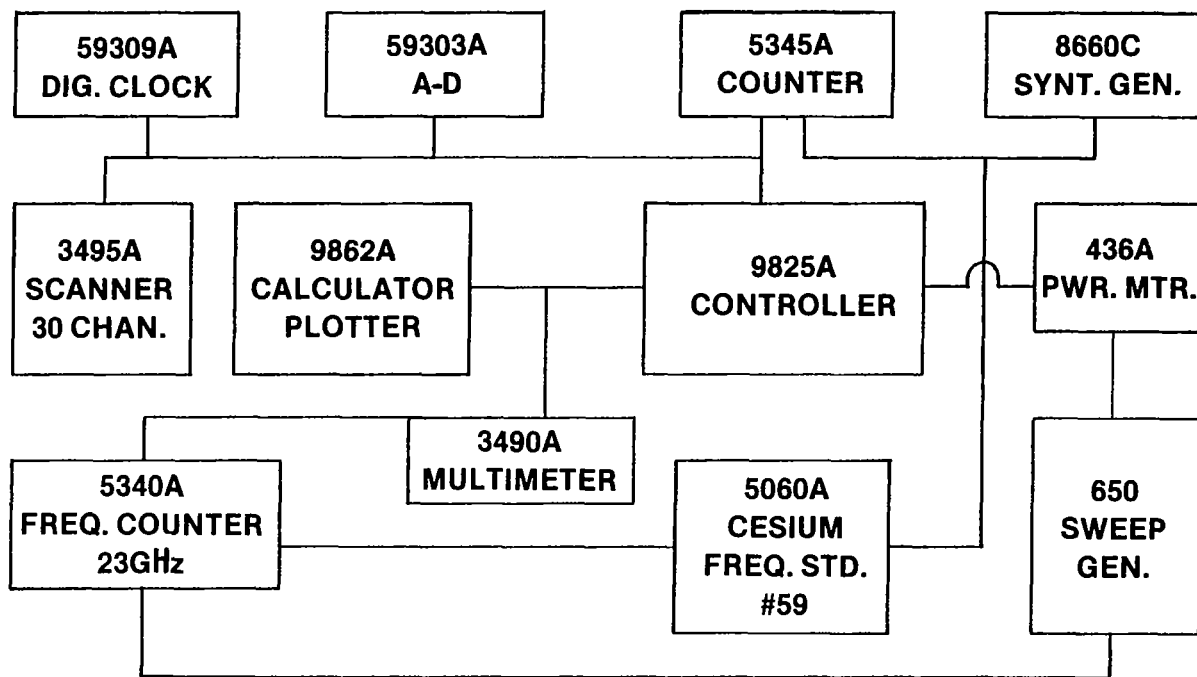
- a. 0 to 448 N (0 to 1,000 lb)
- b. 0 to 26.7 kN (0 to 6,000 lb)
- c. 0 to 222 kN (0 to 50,000 lb)
- d. 0 to 22 MN (0 to 5,000,000 lb)
(2 MN (500,000 lb) dead weight)

WALLOPS FLIGHT CENTER

STATUS

Dick Gladding
Wallops Flight Center

AUTOMATIC TESTING EQUIPMENT QVF LABORATORY



WHITE SANDS TEST FACILITY
CALIBRATION LABORATORIES
STATUS

Grady E. McCright
NASA White Sands Test Facility

CALIBRATION STATUS
WHITE SANDS TEST FACILITY
REPORTING PERIOD OCTOBER 1979 TO OCTOBER 1980

| o MANNING: | | | | AS OF 1 OCTOBER 1980 | |
|--------------------|--------------|-------------|--------------------------|----------------------|-------------|
| | <u>TECH.</u> | <u>ENG.</u> | <u>CIVIL SERVICE</u> | <u>TECH.</u> | <u>ENG.</u> |
| ELECTRICAL CAL. | 6 | 1 | 1/2 | 6 | 1 |
| WORK CONTROL | 1 | | | 1 | |
| PHYSICAL STANDARDS | 2 | | | 2 | |
| MECHANICAL CAL. | <u>4</u> | <u>1</u> | <u>1/2</u> | <u>3</u> | <u>1</u> |
| | 13 | 2 | 1 | 12 | 2 |

o ADJUSTMENTS TO CALIBRATION CYCLES: WSTF SPEC. 005 DATED 1/3/80.

o NUMBER OF INSTRUMENTS CALIBRATED:

| | |
|----------------------|--------------|
| o ELECTRICAL CAL. | 2,448 |
| o PHYSICAL STANDARDS | 888 |
| o MECHANICAL CAL. | <u>3,845</u> |
| | 7,181 |

o NUMBER OF INSTRUMENTS REPAIRED: (MAJOR REPAIR - MORE THAN ONE HOUR)

| | | |
|----------------------|-----|-----|
| o ELECTRICAL CAL. | 979 | 40% |
| o PHYSICAL STANDARDS | 133 | 15% |
| o MECHANICAL CAL. | 200 | 5% |

NOTE: ADJUSTMENTS AND MAJOR REPAIR ARE PERFORMED DURING CALIBRATION.

o TURNAROUND TIME:

| | WITHIN 1 WORKING DAY | WITHIN 5 WORKING DAYS | WITHIN 10 WORKING DAYS | WITHIN 20 WORKING DAYS | GREATER THAN 20 WORKING DAYS |
|--------------------|----------------------------|-----------------------------|------------------------------|------------------------------|---------------------------------------|
| ELECTRICAL CAL. | 9% | 17% | 24% | 14% | 36% |
| PHYSICAL STANDARDS | 20% | 60% | 10% | 10% | |
| MECHANICAL CAL. | 20% | 60% | 20% | | |

NOTE: WORK ORDERS ARE SCHEDULED AND PROCESSED BY NEED DATES.

o AVERAGE CALIBRATION HOURS/INSTRUMENT

| | |
|--------------------|------|
| ELECTRICAL CAL. | 4.06 |
| PHYSICAL STANDARDS | 3.49 |
| MECHANICAL CAL. | 1.88 |

NOTE: THIS AVERAGE CALIBRATION TIME PER INSTRUMENT INCLUDES ADJUSTMENTS AND REPAIR TIME.

o TRAINING:

CONTINUED PROVIDING SELF-TRAINING COURSES IN DIGITAL ELECTRONICS AND MICROPROCESSOR THEORY. HAVE OBTAINED ARMY TRAINING VIDEO TAPES ON TRANSISTOR THEORY, SCOPE AND DIGITAL VOLTMETER CALIBRATION. ALSO OCCASIONALLY SEND PERSONNEL TO VENDOR CLASSES AND SEMINARS. ENGINEERS GENERALLY ATTEND NCSL.

o QUALITY ASSURANCE IS PERFORMED BY ENGINEERS VERIFYING AT LEAST THREE INSTRUMENTS PER WEEK PER LAB. THIS CHECKS TECHNICIAN'S METHODS, PROCEDURE, DATA SHEETS, QUALITY, AND ACCURACY.

o GIDEP:

RECEIVED THE GIDEP CALIBRATION PROCEDURE FILES IN OCTOBER 1979. ESTIMATED TIME SAVED USING GIDEP VS. WRITING LJI IS 624 HRS/YR. COST SAVINGS IS \$7,800 PER YEAR. ANOTHER ADVANTAGE OF THE GIDEP FILES IS BEING ABLE TO DETERMINE WHAT EQUIPMENT IS REQUIRED TO CALIBRATE NEW ITEMS.

o POPULATION OF INSTRUMENTS REQUIRING CALIBRATION:

| | |
|------------------------------------|--------------|
| ELECTRICAL CAL. | 4,000 |
| PHYSICAL STANDARDS/MECHANICAL CAL. | <u>4,100</u> |
| | 8,100 |

o ATE:

SINCE THE 1979 WORKSHOP, WSTF HAS CONDUCTED A STUDY ON AVAILABLE ATE USAGE FOR CALIBRATION LABS. OUR STUDY FOUND THAT THE CAL. LAB EQUIPMENT VENDORS ARE VERY ACTIVELY PROVIDING IEEE-488 BUS COMPATIBLE CALIBRATION EQUIPMENT, FOR EXAMPLE THE TEKTRONIX MODEL CG551AP MICROPROCESSOR-BASED OSCILLOSCOPE CALIBRATION GENERATOR.

WE ARE NOW IN THE PROCESS OF OBTAINING THE EQUIPMENT TO SET UP AN AUTOMATED OSCILLOSCOPE CALIBRATION STATION USING A 8032 COMMODORE PET AND THE TEKTRONIX CG551AP CALIBRATION GENERATOR. THE FIRST YEAR'S COST SAVINGS IN MANPOWER SHOULD PAY FOR THE COMPLETE STATION AND PROVIDE MUCH FASTER TURNAROUND ON SCOPES. WE CURRENTLY ARE USING A RUSKA-KEATHLEY 6000 ATE FOR PRESSURE TRANSDUCER CALIBRATION.

o MAP (NBS):

WE HAVE SUCCESSFULLY COMPLETED A VOLT TRANSFER BETWEEN NBS-WSTF AND WSMR. WE NOW HAVE THE DATA AND WHEN NBS HAS AN AVAILABLE VOLT BOX WILL TRY ANOTHER TRANSFER WITH WSMR AS THE PIVOT LAB. WE ALSO PARTICIPATE WITH WSMR ON THE RESISTOR TRANSFER.

o PROBLEM AREAS

- A. HEADQUARTERS DECALS
- B. SLOW RESPONSE FROM NBS
- C. FUNDING - EQUIPMENT REPLACEMENT AND MANPOWER
- D. WALK-IN WORK
- E. PARTS DELIVERY

o FUTURE PROJECTIONS

- A. PURCHASE A DC CURRENT COMPARATOR
- B. REPLACE OBSOLETE SCOPES AND OTHER INSTRUMENTS
- C. EXPAND ATE FOR TEMP., DVM, ELECT. STANDARDS.
- D. PURCHASE A LASER INTERFEROMETER FOR MAP PROGRAM ON GAUGE AND ANGLE BLOCK STANDARDS
- E. REPLACE LEEDS-NORTHROP PRT BRIDGE FOR INCREASED SPEED
- F. EXPAND TRAINING FOR ADVANCED TECHNOLOGY.

MEASUREMENT QUALITY ASSURANCE AND
NBS CALIBRATION SERVICES

Norman Belecki
National Bureau of Standards

NBS CALIBRATION SERVICES

- RITUALIZED MEASUREMENTS
 - COMPUTERIZED DATA ANALYSIS
- AND
DECISION MAKING

MEASUREMENT ASSURANCE-

DOCUMENTING SCIENTIFICALLY THAT MEASUREMENTS ARE
APPROPRIATE AND OF ADEQUATE ACCURACY
TO MEET REQUIREMENTS ON A CONTINUING BASIS

TWO ACTIVITIES

I. CONTINUAL QUANTIFICATION OF RANDOM MEASUREMENT ERROR AND PREDICTABLE INSTRUMENTATION BEHAVIOR AT THE MEASUREMENT SITE

CHECK STANDARDS

CONTROL CHARTS

STATISTICAL ANALYSIS

II. PERIODIC DETERMINATION OF SYSTEMATIC ERROR (OFFSET FROM UNITS REPRESENTED IN NATIONAL STANDARDS)

MAP SERVICES

USE OF NBS EQUIPMENT AND DATA ANALYSIS

CALIBRATION SERVICES

USE OF NASA TRANSPORT STANDARDS

NBS MAP SERVICES

- AIMED AT BEST POSSIBLE TRANSFER
- MANPOWER INTENSIVE
- MUCH DATA ANALYSIS

NBS WILL SUPPORT USE OF CALIBRATION SERVICES FOR MAP'S

BY

- A. GENERATING TUTORIAL INFORMATION
- B. SUPPLYING SOFTWARE
- C. PROVIDING CONSULTING HELP

NASA CAN HELP MAP SERVICES

1. DEFINE ACCURACY REQUIREMENTS
2. PROCESS PART OF THE DATA
3. PROVIDE TRANSPORT STANDARDS

NBS CALIBRATION SERVICES USED BY NASA

Grady E. McCright
NASA White Sands Test Facility

SPECIAL NBS SERVICES

- o PERSONAL CONTACTS WITH NBS EXPERTS HAVE PROVEN VITAL
 - o NBS PERSONNEL VERY KNOWLEDGEABLE
 - o NBS PERSONNEL WILLING TO PROVIDE ASSISTANCE
 - o NBS ASSISTANCE SAVES NASA RESEARCH TIME AND MONEY
- o UNIQUE TEST EQUIPMENT DESIGN AND CONSTRUCTION
 - o AC TO DC CONVERTER - JSC
 - o TELEVISION TIME COMPARATOR - JSC
 - o 30 MHz ATTENUATOR - JSC
- o MEASUREMENT ASSURANCE PROGRAMS
 - o PROVIDE AN END TO END VERIFICATION OF THE FIELD LABORATORY CERTIFICATION
 - o LESS COSTLY
 - o DEVELOP CLOSE RELATIONSHIP WITH PERSONNEL AT NBS AND OTHER LABORATORIES IN MAP PROGRAM
 - o ADDITIONAL MAP TRANSFER STANDARDS AND PROGRAMS WOULD BE HELPFUL

PROBLEM AREAS

- o NBS REORGANIZATION AND CUTBACKS
 - o MECHANICAL FLOW - CUTBACK FROM 6 TECH. TO 2 TECH. & 2 PART-TIME
- o SLOW RESPONSE: VOLT - 18 MOS. TURNAROUND - WSTF
FLOW - 12 MOS. TURNAROUND - KSC
MAP DATA GENERALLY SLOW - LARC-JSC-WSTF-KSC
- o DISCONTINUED SERVICES
 - o CALIBRATION OF MAGNETS
 - o CALIBRATION OF UNIVERSAL RATIO SET

RECOMMENDATIONS

- o NASA HEADQUARTERS PROVIDE ADDITIONAL FUNDS FOR NBS TO CONTINUE SERVICES
- o NASA CENTERS PROCURE SELF-CALIBRATING MODELS WHEREVER POSSIBLE
- o NASA CENTERS USE SECONDARY AND/OR OTHER GOVERNMENT LABORATORIES WHEREVER POSSIBLE
- o DISCUSSION

THE JET PROPULSION LABORATORY LOAN POOL

Robert E. Martin and Harry J. Stephens
Jet Propulsion Laboratory
California Institute of Technology

ABSTRACT

Management of Government property requires that available equipment be utilized to the maximum extent possible. The Instrument Loan Pool at the Jet Propulsion Laboratory (JPL) is an important element in fulfilling this property utilization requirement. The following paper discusses the development and operation of the JPL Instrument Loan Pool. After eleven years of operation, the Instrument Loan Pool has proven to be a cost effective means of satisfying requirements for general purpose instruments.

BACKGROUND

The Instrumentation Section was formed and chartered in the mid 1950's to provide instrumentation discipline support to all the technical activities conducted by the Jet Propulsion Laboratory. As such, the role of the Section vacillated between a czar with total control over all instrumentation and a secondary activity that responded only to specific requests. In the period of 1960 to 1965, various means for cooperative funding and utilization of instruments and instrumentation systems were tried. In 1966, an Instrument Loan Pool was formed to support a small number of compatible activities (mostly chemical propulsion) which voluntarily participated by providing both funding and demands on the pool. The voluntary system continued through FY 1968. A management review started in 1967 studied the methods and processes by which JPL planned and controlled the acquisition of equipment. The study indicated duplication and inefficient use of available equipment and that a large potential savings existed if a mechanism for sharing general purpose instruments could be instituted. After considerable additional study, it was decided that at the start of FY 1969 a mandatory Instrument Loan Pool system would be initiated to provide all "General Use Type" instruments (see Appendix for details on operating procedures).

The transition to an expanded and mandatory Instrument Loan Pool for providing all general purpose instruments was implemented on a "soft" basis so that no ongoing activity would be fatally hurt by the financial change of instrument costs going from principally a capitalization expense to an operating expense. The transition took over five years. After eleven years of operation, there are still scars in some places. The resourcefulness of the user community is such that they have found various loopholes in the "bureaucratic system" which they can exploit to their advantage. For a small number of users the classical battle of optimization between subsystem vs system still rages. We are currently updating the JPL Standard Practice Instructions to close these loopholes.

In 1974 a high level management review of the Instrument Loan Pool operation was conducted to see if the Loan Pool was cost effective and should be retained. The outcome of the review was a continued endorsement by JPL management and the directive to continue the operation.

At this point in the explanation of the loan pool concept it is probably beneficial to describe the situation as users perceive it. Some researchers view the acquisition of equipment on their on-going research activity as the benefit they derive from good performance and the investment which enables them to continue to obtain future work. The equipment that they control is their security blanket. This is counter to the Government's policy that the equipment is provided for specifically defined work and becomes available for reassignment to other potential users at the completion of the task.

While the intent of the loan pool concept is to increase equipment utilization and thereby decrease the total cost of new equipment procurements, it also provides a mechanism for accumulating funds for financing acquisition of new instruments. It is difficult to determine if the researcher gains or loses when he operates in accordance with the loan pool procedure in which instrument costs are annual operating costs vs bearing the full procurement cost of new instruments in a single fiscal year. A growing number of researchers are now actively supporting the loan pool concept because of the pool's ability to provide up-to-date instruments to meet new requirements.

OPERATING CHARACTERISTICS

The Instrument Loan Pool contains over 5100 instruments of 1800 different makes and models, with an acquisition cost of approximately \$8,400,000. It serves a population of about 3900 users which operate in approximately 550 teams. The users share equipment and have a high degree of cooperation within the teams. Typically, 60% of the inventory is out on loan at any one time, and 12-13 new loan transactions occur each working day.

The management of loan pool inventory is very complex and simple indexes as a measure of performance can be very misleading. Most commercial instrument rental companies operate at better than 70% of their inventory out on loan. But at JPL, there are three factors which tend to drive the percentage out on loan down to a lower value. First, we are not trying to optimize return on capital invested in the loan pool, but to reduce total cost of the end product to the Government. The driver here is to minimize labor costs by preventing work blockages because of lack of required instruments. The next factor is that the Loan Pool handles instruments which commercial firms will not handle because of low utilization rates. But if the instruments are essential to getting the job done, even though used only occasionally by a set of users, then the Loan Pool will retain the instrument in its inventory. The third factor is essentially psychological and marketing oriented. The Loan Pool must convince the user community that it can supply the common use, popular instruments on demand. If it does not, then the user

community would begin storing instruments locally to ensure availability. The result is the JPL Instrument Loan Pool is operated at a relatively low percentage of inventory out on loan, and the instruments available for loan are made very visible.

The procurements of new instruments are initiated by the Loan Pool users in response to their specific requirements. The Loan Pool factors in judgments that are associated with the in-service record of like equipment and the cost associated with maintenance, repair and calibration. Occasionally the Loan Pool must verify the long term needs and potential for sharing. We have the option of renting equipment from industry instead of buying. This has been explored a number of times but never exercised by the Loan Pool.

Because the Loan Pool user has a prime role in determining the composition of the loan pool inventory, concerns for the adequacy of the planning can arise. In FY 1980, the Loan Pool purchased 294 new instruments for a cost of \$1,062,000. The Loan Pool conducts periodic reviews and analysis of inventory utilization to ascertain if undesirable trends are occurring and corrective actions are required. To date, no changes in operating policies have resulted. The types of analysis performed are percentage of instruments in stock vs year purchased, reasons for excessing equipment, utilization of equipment during its first year after purchase, and typical loan periods. Tables 1 through 4 show the results of these analysis. Lists of instruments, which have not been used for extended periods of time, are reviewed. Previous users are contacted to see if there is potential future use for the equipment and if so, it should be retained. Approximately 100 items are being retained on this basis.

The monthly rental charge for instruments averages about 2.5% of the acquisition cost of the instrument. Approximately half of the charge goes toward acquiring new instruments. The remaining half is divided into two almost equal parts, one for covering the administrative and technical support costs and the other the direct costs of maintenance, repair, and calibration of the loan pool instruments. The maintenance, repair, and calibration costs are kept low by providing on-site contractor support servicing and maintaining a reasonable level of standardization.

CONCLUDING REMARKS

The Instrument Loan Pool is an important element of the JPL property management system through which instrument utilization is increased and work blockages minimized. It also provides the mechanism for keeping the inventory of general use instruments up-to-date to meet the needs of the technology development activities of the laboratory. The loan pool concept has firm acceptance at JPL and is believed to be cost effective.

TABLE 1. - PERCENT OF INSTRUMENT ON LOAN VS YEAR OF PURCHASE

| Fiscal Year | % on Loan* |
|----------------|------------|
| 1969 or before | 58.1 |
| 1970 | 78.3 |
| 1971 | 73.9 |
| 1972 | 59.9** |
| 1973 | 41.8** |
| 1974 | 81.1 |
| 1975 | 84.6 |
| 1976 | 74.8 |
| 1977 | 83.1 |
| 1978 | 92.4 |
| 1979 | 91.0 |
| 1980 | 94.0 |

*Items valued over \$500.

**System test complex equipment used for Viking and Voyager not yet required for Galileo Project.

TABLE 2. - SURVEY SAMPLE OF INSTRUMENTS DELETED FROM THE LOAN POOL INVENTORY
(352 out of 1800)

| % of Instruments Deleted | Average Life Span (yrs) | Reason for Deletion |
|--------------------------------|-------------------------------|--------------------------|
| 71.8 | 12.3 | Obsolete |
| 19.2 | 10.8 | No Need |
| 3.2 | 16.8 | Excessive Age |
| 5.8 | 9.9 | Beyond Economical Repair |

TABLE 3. - FIRST FIVE YEARS UTILIZATION OF INSTRUMENTS

| Year Purchased | FY 1969 | FY 1972 | FY 1975 |
|--|---------|---------|---------|
| Number of Instruments | 167 | 210 | 193 |
| Total Cost (\$K) | 262 | 426 | 495 |
| Average Usage* (%) | 86.7 | 82.1 | 82.8 |
| Number of Instruments used 100% | 92 | 81 | 70 |
| Number of Instruments used under 50% | 18 | 25 | 21 |
| Cost of Instruments used under 50% (\$K) | 25.3 | 49.7 | 33.6 |

*(Months on loan divided by months on inventory) x 100.

TABLE 4. - LOAN PERIOD DISTRIBUTION

| Months of Loan (Months) | Percent of Loans (%) |
|-------------------------------|----------------------------|
| 1-2 | 31.4 |
| 3-4 | 12.3 |
| 5-6 | 6.1 |
| 7-8 | 6.5 |
| 9-10 | 5.5 |
| 11-12 | 3.6 |
| 13-14 | 5.2 |
| 15-16 | 4.3 |
| 17-18 | 3.6 |
| 19-20 | 1.7 |
| 21-22 | 1.5 |
| 23-24 | 1.9 |
| over 24 | 16.3 |

APPENDIX

OPERATING PROCEDURES OF THE JPL INSTRUMENT LOAN POOL

INTRODUCTION

The Instrument Loan Pool is a technical service provided by the Instrumentation Section. It was organized to provide an institutional basis for the laboratory-wide sharing of general-purpose test equipment. As such, the Instrument Loan Pool procures, assumes custody, maintains, and rents all "General Use Type" instruments.

OBJECTIVE

The objective set forth for the Instrument Loan Pool is to achieve high utilization of equipment with minimum work blockages. This is accomplished by

- Affording the opportunity to groups who carry out tasks of limited duration and funding to use instruments during these short periods without incurring the expense of buying them.
- Providing quick response to immediate instrument needs of a task.
- Assuring high performance of instruments through periodic and uniform calibration and servicing.

OPERATIONAL PLAN

The Instrument Loan Pool issues equipment to the user on a monthly rental basis. Equipment which a user requires but which is not currently available in the Loan Pool is acquired by the Loan Pool and rented to the user. The Loan Pool will loan instruments to any employee who requests use and provides a valid account code number for payment of the monthly rental charge. The policy governing issuance of instruments is strictly "first come, first served." Priority for obtaining Loan Pool instruments on any other basis must be handled through line authority. Loans can also be made to on-lab contractor personnel. Responsibility for their loans however, rests with the contractor's cognizant engineer and all the loan records reflect the engineer's name.

"GENERAL USE TYPE" EQUIPMENT

To be classified as a "General Use Type" instrument and qualify as an instrument which the Instrument Loan Pool would accept, purchase, maintain and provide to users, it should meet the following criteria:

- a. Be electronic, electrical, electro-mechanical, or optical in nature and be capable of being directly or indirectly used in making a measurement.
- b. Be a portable, semi-portable, or rack mountable instrument.
- c. Be a general-use instrument such as might be listed in a catalog; and not be a special one-of-a-kind instrument built to a unique set of specifications. See the "Instrument Loan Pool Equipment Catalog" for a list of typical loan pool equipment.
- d. Not be an essential component of a special purpose instrument and normally procured as part of a complete system.
- e. Not be an instrument which will be physically consumed in experimental tests or operations.
- f. Not be a permanently installed component of an institutionally recognized facility.

A facility is considered to be an assembly of instruments whose every component is required in order to maintain an integrated system identity. An institutionally recognized facility is one that serves many projects over a long period of time, is not dedicated to a single task or project, and is funded on an institutional basis. Examples of institutionally recognized facilities are The Mission Control and Computing Center and the Environmental Test Lab.

- g. Not be under control of, or the responsibility of, an O & M contractor.
- h. Not be an instrument which is extensively modified by the manufacturer or by JPL to the point where, in the opinion of the Loan Pool management, the cost of restoring the instrument to its original function or purpose would be prohibitive.
- i. Not be an instrument which is a specified deliverable to the funding source.

RENTAL CHARGE

A "Rental Charge" is levied on the user each month the instrument is in his possession. The charge is determined from the cost category of the rented instrument and is based upon the historical experience of keeping instruments maintained and calibrated and estimates of the activity level and the funds needed to acquire new instruments. Maintenance and calibration costs are consequently borne by the Loan Pool so that the user need only consider the rental costs in his budget. A sample rate chart is shown in Table A-1. If a user borrows a group of instruments which comprise a system, he is charged a "system rate" which is derived by adding the acquisition costs of the separate items and then using the table to find the charge. This usually results in a lower charge to the user. For the purposes of determining "rental rate" a system is defined as a group of interdependent items designed by the manufacturer to act as a unit in order to perform a specific task and whose total value exceeds \$10,000.

A Loan Pool "month" is defined to be the period of time from the sixteenth day of one calendar month through the fifteenth day of the following calendar month.

The sample rates shown in Table A-I may be modified for specific instruments if, because of their nature, they incur higher or lower maintenance or calibration costs than the average instrument in the same acquisition cost category. The actual rental charge for an instrument is indicated in the Instrument Loan Pool Equipment Catalog in the form of "rent code number." Minor adjustments to the value of a "rent code number" unit is made annually so that in the long term the costs are balanced with the income derived from the rentals.

REQUESTING AN INSTRUMENT FOR LOAN

The requestor contacts the Loan Pool to see if the required instrument or a satisfactory substitute is available. If the item is available, the requestor furnishes his name, employee number, telephone number, location where instrument should be sent, and the account code number to be charged. This information is recorded on a charge out card (see Figure A-1). He should also state if special calibration or instruction manuals are required.

ACQUISITION OF INSTRUMENTS

The Loan Pool will acquire instruments in order to meet the requirements of the user. Equipment may be acquired by several methods:

- Direct procurement of new instruments with Loan Pool funds.
- Transfer from a user of excess instruments.
- Transfer from another government agency.

TABLE A-1. - INSTRUMENT LOAN POOL MONTHLY CHARGE SCHEDULE

| ACQUISITION COST | | \$ RATE | CHARGE NUMBER | ACQUISITION COST | | \$ RATE | CHARGE NUMBER |
|------------------|------|------------|------------------|------------------|--------|------------|------------------|
| FROM | TO | | | FROM | TO | | |
| 0 | 150 | 6.00 | 1 | 4761 | 5050 | 120.00 | 20 |
| 151 | 300 | 12.00 | 2 | 5051 | 5340 | 126.00 | 21 |
| 301 | 450 | 18.00 | 3 | 5341 | 5630 | 132.00 | 22 |
| 451 | 600 | 24.00 | 4 | 5631 | 5920 | 138.00 | 23 |
| 601 | 750 | 30.00 | 5 | 5921 | 6230 | 144.00 | 24 |
| 751 | 1020 | 36.00 | 6 | 6231 | 6530 | 150.00 | 25 |
| 1021 | 1310 | 42.00 | 7 | 6531 | 6800 | 156.00 | 26 |
| 1311 | 1600 | 48.00 | 8 | 6801 | 7080 | 162.00 | 27 |
| 1601 | 1880 | 54.00 | 9 | 7081 | 7380 | 168.00 | 28 |
| 1881 | 2170 | 60.00 | 10 | 7381 | 7650 | 174.00 | 29 |
| 2171 | 2450 | 66.00 | 11 | 7651 | 7950 | 180.00 | 30 |
| 2451 | 2740 | 72.00 | 12 | 7951 | 8230 | 186.00 | 31 |
| 2741 | 3030 | 78.00 | 13 | 8231 | 8530 | 192.00 | 32 |
| 3031 | 3320 | 84.00 | 14 | 8531 | 8830 | 198.00 | 33 |
| 3321 | 3610 | 90.00 | 15 | 8831 | 9100 | 204.00 | 34 |
| 3611 | 3890 | 96.00 | 16 | 9101 | 9400 | 210.00 | 35 |
| 3891 | 4180 | 102.00 | 17 | 9401 | 9700 | 216.00 | 36 |
| 4181 | 4480 | 108.00 | 18 | 9701 | 11,000 | 222.00 | 37 |
| 4481 | 4760 | 114.00 | 19 | over | 11,000 | 2.04% | |

The acquisition by direct procurement is initiated when the required instrument is not otherwise available, or when the Loan Pool cannot provide a substitute to meet the requirements of the user. Purchase of a new instrument begins with the INSTRUMENT LOAN POOL EQUIPMENT REQUEST (Figure A-2). The purchase requisition will then be processed through the Loan Pool management signature chain of approval prior to the procurement action. The cost of an instrument purchased by the Loan Pool is charged to a holding account so that user sees only the rental charge for the time he is using the instrument.

MAINTENANCE AND CALIBRATION

The Instrument Loan Pool is responsible for the maintenance and calibration of all loaned instruments and no instrument is loaned out unless there is a valid, in-date calibration sticker affixed to it. If a loaned instrument is to be used in support of a flight project, the instrument is periodically maintained and calibrated and entered into a recall notification system. Maintenance and calibration are handled whenever possible on an exchange basis so the user will be without an instrument for a minimum amount of time. Repair and calibration charges are charged to the user's account code number for any abnormal use of the equipment such as negligence, misuse or willful abuse.

REPORTS AND PUBLICATIONS

Each month, the Loan Pool sends to each Division a report listing the instruments on loan to the various members of the organization. Opposite each instrument, the monthly rental charge and the account code number being charged is shown. The initial loan date is also shown. A semi annual report by user name is mailed to the user for his inventory record. The Loan Pool also publishes, on a yearly basis, an "Instrument Loan Pool Equipment Catalog" which lists various instruments available for rent, major specifications, and rent code number.

ORGANIZATION

The Loan Pool is operated by a staff of technically qualified people who handle the rental operation. The Loan Pool provides advice to help the user in the selection of an instrument best suited to his purpose, or will recommend instruments which have proven superior from the standpoint of performance and economy. Actual maintenance and calibration of instruments are taken care of by other elements of the Instrumentation Section.

LOAN POOL CHARGE OUT RECORD

JPL 0980-2 R 8/76

| | | | | | |
|-----------------------|-----------------|-----------------|-------------------------|---------------------|-------------|
| 1. IDENTIFICATION NO. | 2. NOMENCLATURE | 3. MANUFACTURER | 4. MODEL NO. | 5. SERIAL NO. | 6. QUANTITY |
| 7. REQUESTER | 8. EXT. | 9. EMP. NO. | 10. LOCATION BLDG. ROOM | 11. ACCOUNT CODE | |
| SIGNATURE | | LOAN DATE | | ACCESSORY EQUIPMENT | |

LOAN POOL USE ONLY

| |
|-------------|
| PRICE |
| CHARGE CODE |

PROPERTY FILE

Figure A-1.- Loan pool charge out record form.

INSTRUMENT LOAN POOL EQUIPMENT REQUEST

| | | | | | |
|---|--|----------------------------------|-----------|--------------|---------------|
| REQUESTER | | EXT. | EMPL. NO. | REQUEST DATE | REQUIRED DATE |
| LOANED EQUIPMENT LOCATION BLDG. ROOM | | REQUESTING SECTION - NAME AND NO | | ACCOUNT CODE | |

| ITEM NO | QUANTITY | DESCRIPTION | LOAN POOL USE ONLY | | | | |
|---------|----------|-------------|--------------------|-------|-----------------------|---------------------------|-----------------------------------|
| | | | SOURCE | | IDENTIFICATION NUMBER | SERVICE CHARGE UNIT PRICE | REQUISITION PURCHASE ORDER NUMBER |
| | | | STOCK | ORDER | | | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |

APPLICATION (WHY IS EQUIPMENT REQUIRED)

| | | | |
|---------------------------|------|--------------------------|------|
| GROUP SUPERVISOR APPROVAL | DATE | SECTION MANAGER APPROVAL | DATE |
|---------------------------|------|--------------------------|------|

LOAN POOL JUSTIFICATION

LOAN POOL USE ONLY

COPY DISTRIBUTION: WHITE - LOAN POOL FILE
GREEN - PROCUREMENT
CANARY - P.O. RECEIPT

PINK - SUSPENSE FILE
GOLDENROD - REQUESTER RETAIN THIS COPY

JPL 3343 S R 3/76

Figure A-2.- Instrument loan pool equipment request form.

AGENDA

- BACKGROUND
- OPERATING PLAN
- USER CHARACTERISTICS
- OPERATING CHARACTERISTICS
- PERFORMANCE STATISTICS
- TRENDS
- CONCLUSIONS

INSTRUMENT LOAN POOL

- GOVERNMENT PROPERTY MANAGEMENT
 - MAXIMIZE UTILIZATION
 - MINIMIZE PROCUREMENTS
- LOAN POOL IS MECHANISM FOR
 - SHARING OF EQUIPMENT
 - REDUCING WORK BLOCKAGES
 - PROVIDING NEW INSTRUMENTS

BACKGROUND

- INSTRUMENTATION SECTION FORMED IN MID 1950'S
- VOLUNTARY LOAN POOL FORMED IN 1966
- MANDATORY LOAN POOL DIRECTED AT START OF 1969
- TOP MANAGEMENT REVIEW CONDUCTED IN 1974

OPERATING PLAN

- "GENERAL USE TYPE" INSTRUMENT
- FIRST COME, FIRST SERVED
- MONTHLY RENTAL CHARGE
 - % OF ACQUISITION COST (~2.5%)
- USER INITIATE REQUEST FOR NEW INSTRUMENTS

"LOAN POOL TYPE" INSTRUMENT

- SHOULD BE:
 - DIRECTLY OR INDIRECTLY USED IN MAKING A MEASUREMENT
 - PORTABLE, SEMI PORTABLE, OR RACK MOUNTABLE
 - GENERAL-USE, AS LISTED IN A CATALOG
- SHOULD NOT BE:
 - PART OF SPECIAL PURPOSE INSTRUMENT
 - CONSUMED IN TEST OR OPERATION
 - PERMANENTLY INSTALLED COMPONENT OF INSTITUTIONALLY RECOGNIZED FACILITY
 - UNDER THE CONTROL OF, OR RESPONSIBILITY OF O&M CONTRACTOR
 - EXTENSIVELY MODIFIED
 - DELIVERABLE ITEM

USER CHARACTERISTICS

- ~ 3900 PEOPLE
- ~ 550 TEAMS
- RANGE FROM
 - VERY SOPHISTICATED TO NAIVE
 - COOPERATIVE TO HOSTILE

OPERATING CHARACTERISTICS

| | |
|----------------------------|-------------|
| • INVENTORY | 5100 ITEMS |
| • MAKES/MODELS | 1800 |
| • COST OF INVENTORY | \$8,400,000 |
| • % ON LOAN | 60 |
| • NEW LOANS PER DAY | 12 - 13 |
| • NEW INSTRUMENTS IN FY'80 | |
| • NUMBER | 294 |
| • COST | \$1,062,000 |

PERFORMANCE STATISTICS

| | <u>FY'77</u> | <u>FY'78</u> | <u>FY'79</u> | <u>FY'80</u> |
|------------------------|--------------|--------------|--------------|--------------|
| LOAN POOL INVENTORY | | | | |
| BEGINNING OF YEAR | 5341 | 5374 | 5070 | 5097 |
| NEW INSTRUMENTS | 241 | 138 | 309 | 294 |
| TRANSFERS IN | 78 | 44 | 77 | 76 |
| SURVEYED OUT | (286) | (486) | (359) | (287) |
| END OF YEAR | 5374 | 5070 | 5097 | 5174 |
| ACTIVITY | | | | |
| INSTRUMENTS ON LOAN | 3769 | 2791 | 2684 | 3014 |
| % OF INVENTORY ON LOAN | 60 | 45 | 53 | 60 |

LOAN PERIOD DISTRIBUTION

| <u>MONTHS OF LOAN (MONTHS)</u> | <u>PERCENT OF LOANS (%)</u> |
|------------------------------------|---------------------------------|
| 1 - 2 | 31.3 |
| 3 - 4 | 12.3 |
| 5 - 6 | 6.1 |
| 7 - 8 | 6.5 |
| 9 - 10 | 5.5 |
| 11 - 12 | 3.6 |
| 13 - 14 | 5.2 |
| 15 - 16 | 4.3 |
| 17 - 18 | 3.6 |
| 19 - 20 | 1.7 |
| 21 - 22 | 1.5 |
| 23 - 24 | 1.9 |
| OVER 24 | 16.3 |

PERCENT OF INSTRUMENT ON LOAN VS YEAR OF PURCHASE

| <u>FISCAL YEAR</u> | <u>% ON LOAN</u> |
|--------------------|------------------|
| 1969 OR BEFORE | 58.1 |
| 1970 | 78.3 |
| 1971 | 73.9 |
| 1972 | 59.9 |
| 1973 | 41.8 |
| 1974 | 81.1 |
| 1975 | 84.6 |
| 1976 | 74.8 |
| 1977 | 83.1 |
| 1978 | 92.4 |
| 1979 | 91.0 |
| 1980 | 94.0 |

**FIRST FIVE YEARS
UTILIZATION OF INSTRUMENTS**

| <u>YEAR PURCHASED</u> | <u>FY 1969</u> | <u>FY 1972</u> | <u>FY 1975</u> |
|--|----------------|----------------|----------------|
| NUMBER OF INSTRUMENTS | 167 | 210 | 193 |
| TOTAL COST (\$K) | 262 | 426 | 495 |
| AVERAGE USAGE * (%) | 86.7 | 82.1 | 82.8 |
| NUMBER OF INSTRUMENTS USED 100% | 92 | 81 | 70 |
| NUMBER OF INSTRUMENTS USED UNDER 50% | 18 | 25 | 21 |
| COST OF INSTRUMENTS USED UNDER 50% (\$K) | 25.3 | 49.7 | 33.6 |

* (MONTHS ON LOAN DIVIDED BY MONTHS ON INVENTORY) X 100

INSTRUMENTS DELETED FROM THE LOAN POOL INVENTORY
(SAMPLE OF 352 OUT OF 1800)

| <u>% OF INSTRUMENTS DELETED</u> | <u>AVERAGE LIFE SPAN (YRS)</u> | <u>REASON FOR DELETION</u> |
|---|--|----------------------------|
| 71.8 | 12.3 | OBSOLETE |
| 19.2 | 10.8 | NO NEED |
| 3.2 | 16.8 | EXCESSIVE AGE |
| 5.8 | 9.9 | BEYOND ECONOMICAL REPAIR |

TRENDS

- SMALL EVOLUTIONARY CHANGES
- INSTRUMENT PROCUREMENTS
 - SYSTEMS
 - INCREASED UNIT COST
- INCREASED ACCEPTANCE OF CONCEPT

MANAGEMENT OF RESEARCH INSTRUMENTATION AT THE

LANGLEY RESEARCH CENTER

Earl S. German, Jr.
Langley Research Center

Presented is an overview of the concept, organization, and operation of Langley's management plan for its \$81 million instrument inventory. Information is given on the procurement, maintenance, distribution, and application of these instruments. Included are the management roles played by specific Langley groups as well as the roles of support services contractors.

INTRODUCTION

Langley Research Center has a complement of over 100 research facilities instrumented by a wide variety of electronic and electromechanical instruments. This instrument pool consists of approximately 33,000 instruments valued in excess of \$81 million. The management of these instruments utilizes the services of specialists working under a variety of technical and administrative disciplines.

On August 9, 1968, Langley Management Instruction (LMI) 4200.1 was issued to cover the "Utilization and Procurement of Instrumentation." This LMI formally set forth the instrument management program for Langley. The Instrument Research Division (IRD) was given prime responsibility for managing this program. The LMI established two of the working groups involved in the program: The Instrument Control Office (ICO) and the Instrument Coordination Section (ICS). Also established were the positions of Instrument Consultant and Instrument Coordinator. On August 14, 1975, LMI 4200.3 (appendix A) was issued as a revision of 4200.1 to comply with the requirement of NHM 4200.1, NASA Equipment Manual.

In addition to the ICO, the ICS, and consultants, personnel from the Aerosol Measurements Research Branch and six additional organizations within IRD--Instrument Support Section, Optical and Pressure Measurement Section, Digital Data Acquisition Section, Acoustics and Vibration Instrumentation Section, Force and Strain Instrumentation Section, and Dynamic Systems Instrumentation Section--have instrument management responsibilities such as contract monitoring, repair, calibration, and system design.

The ICO, located in the Instrument Research Division, Building 1230, has primary custodial and accountability responsibility for all of these instruments.

The ICS provides liaison between IRD and the various research facilities.

The Instrument Research Division is responsible for instrument repair, calibration, maintenance, and installation. Two support services contracts provide the majority of these services. Personnel from ICO, ISS, OPMS, AVIS, DDAS, ICS, and FSIS monitor the contractors' activities.

Instrument Consultants are a group of instrument specialists available to all Langley personnel to answer questions and make recommendations in particular instrument or measurement areas.

The purpose of this paper is to discuss the various aspects of this instrument management plan so that the reader will have an insight on how it works. Lines of authority, areas of responsibility, current procedures, and services available will be discussed along with an instrument flow chart to aid the instrument user.

DISCUSSION

The Role of the Instrument Control Office

The prime responsibility of the ICO is to be primary custodian of the 33,000 plus research instruments in the instrument pool. (Research instruments are defined as "measuring and control equipment including electronic, electrical and mechanical devices, and photographic equipment.") These instruments are, in turn, issued to individual researchers, usually for an indefinite period, to be used on their research projects. Each line organization at Langley has an instrument custodian (usually the organization head) who has overall responsibility for all instrumentation in his area. Individual instruments are charged to using personnel within the organization. These individual users, known as instrument loanees, are responsible for the proper use and maintenance of each instrument assigned to him/her. All instrument issues are processed by the ICO.

The ICO also maintains a pool of Short Term Loan (STL) and Scheduled Loan (SL) instruments. These are issued to researchers who have a need for a particular instrument for a definite period of time. These instruments can also be issued to the researcher as a temporary replacement for an instrument sent in for repair. The normal loan period for an STL instrument is 20 working days and for an SL instrument is 90 calendar days. There are approximately 1200 instruments in the STL/SL pool. Included is a wide variety of general purpose test equipment such as pocket and desk calculators, oscilloscopes, digital and analog voltmeters, multimeters, and pressure transducers. Also included are accelerometers and associated signal conditioning equipment, audio, video and instrumentation tape recorders, x-y recorders, and self-balancing potentiometers. The ICO has a catalog of these instruments (appendix B shows sample pages) which is available to organizational units and individuals on an as needed basis.

Other responsibilities of the ICO are:

1. Screening of instrument purchase requests for possible availability of the requested instrument from the Langley or other NASA Centers' instrument pool. The information pertaining to equipment at other NASA Centers is available through the NASA Equipment Visibility System (EVS). EVS is a listing of all accountable property with a unit value of \$1,000 or more located at each NASA Center. This listing is updated monthly, placed on microfilm and copies furnished to each Center. The listing shows the item, manufacturer, model, and status (active, in storage, excess, etc.). Should the requested instrument be reflected on EVS as being in a status which would make it available for reassignment, the holding Center is contacted to ascertain if the item can be obtained for use at Langley.

2. Coding purchase requests for applicable instruments so that proper data may be placed in accountability records.

3. Routing instruments to Langley's support services contractors for repair and maintenance (figure 1). This function alone involves the processing of 10,000 to 12,000 instruments a year.

4. Maintaining history on all pool instruments. Included in this history is instrument type, manufacturer, model, serial number, inventory number (if any), acquisition cost, purchase specifications (if available), calibration data (as applicable), and a comprehensive service history. All of this history is filed on microfiche. ICO files presently contain records on approximately 32,000 instruments.

5. Arranging timely demonstrations and displays of instruments by manufacturers and/or their representatives.

6. Initiating the survey of obsolete, worn, and excess instruments.

7. Coordinating loans of instruments to educational institutions and other government agencies.

8. Advising users in the proper use of pool instruments.

9. Assisting instrument consultants in compiling data on instruments in their area of responsibility. The consultant can obtain from the ICO, through an interactive computer terminal, records on instruments on inventory, new procurements, location by building and room, and any other pertinent information desired. ICO also maintains records on instruments repaired, calibrated, and surveyed.

10. Maintaining, on computer, a listing of standards at Langley. This listing contains instrument type, manufacturer, model, serial number, inventory number (if applicable), responsible user, location, last calibration date, and next calibration date. All recall activities are coordinated by the ICO and all data updates for recall records are handled by ICO personnel.

The Role of the Instrument Coordinator

The Instrument Coordination Section (ICS) is charged with the responsibility of providing liaison between the various research facilities and IRD in instrumentation matters.

There is an Instrument Coordinator assigned to each research facility. (A current listing is published in the Langley telephone directory.) It is the responsibility of the coordinator to be aware of the measurement requirements of the facilities to which he is assigned. He works closely with the researchers in his facilities to insure that needed instrumentation is available for carrying out research projects. If appropriate instruments are not available at the facility or from the instrument pool, he insures that purchase requests are initiated to procure the needed instruments (figure 2). He also initiates the necessary work orders to applicable support services contractors for necessary installation, checkout, and calibration of the required instrumentation. He may also be called on to design the instrumentation system needed to measure the various parameters required by the researcher.

The Role of the Instrument Consultant

Instrument Consultants are instrument specialists who have detailed information on particular types of instruments and expertise in their application. (A current list of consultants is published in the Langley telephone directory.) Instruments or measurement fields for which consultants are appointed are: Acoustics, amplifiers (instrumentation, operational), balances, cameras, digital data systems, digital voltmeters, frequency counters, electronic calculators, facility wiring, flowmeters, high-speed photography, laser devices, optics, mirrors and flow visualization systems, load cells, accelerometers, and magnetic tape recorders; also, manometers, dial pressure gages, vacuum gages, oscillographs, oscilloscopes, power supplies, pressure transducers, self-balancing potentiometers, pen recorders, spectroscopy, thermal, and TV systems.

Another important function of the consultant is to report to the Instrument Research Division, at the end of each calendar year, on the current inventory and general activity during the year in their respective instrument areas. This report would include information as to instruments procured and surveyed, current costs, procurement procedures (mass buys, GSA contracts, etc.) and significant technological developments in the consultant's area of responsibility. Individual reports are compiled for reporting to the Director for Electronics.

Other consultant responsibilities include: Establishing, whenever possible, standardized specifications for instruments; reviewing and approving purchase requests for special instruments in his field; initiating training programs as required; advising instrument users on application

procedures when requested; evaluating new instruments for their application to Langley's research programs; and assisting in keeping the STL/SL pools stocked with up-to-date instruments.

The Role of Support Services Contractors

Support services contractors perform the majority of the instrument repair, calibration, maintenance, and installation jobs at Langley. At present, Langley has contracts with two companies to perform these services: Wyle Laboratories, Hampton, Virginia (approximately 155 direct personnel); Modern Machine and Tool Company (MM&T), Newport News, Virginia (approximately 16 direct personnel). The majority of the work contracted by these contractors is performed in their local plants.

Wyle.—The scope of the contract with Wyle Labs is very broad and includes, in part, the repair, calibration, and maintenance of most of the instruments in the instrument pool (approximately 10,000 to 12,000 instruments are serviced a year).

Wyle supports the Digital Data Acquisition Section in the maintenance of facility digital data acquisition systems.

They assist the Instrument Coordination Section in the design, installation, and calibration of facility instrumentation systems.

The majority of Langley's newly purchased instrumentation is received through Wyle's shipping and receiving department. Acceptance testing of these instruments to ascertain that they meet procurement and/or manufacturer specifications is done by the appropriate Wyle technical group. Instruments which fail to meet these specifications are returned to the vendor by Wyle, along with instruments which fail within their warranty periods and also specialized instruments which must be repaired by the manufacturer for one reason or another.

There are six IRD sections involved in the monitoring and evaluation of the activities of the contractor. Personnel from the Instrument Support Section monitor electronic repair, tape recorder repair, electromechanical repair, electrical calibration, temperature calibration, flow calibration, field service, and shipping and receiving. Optical and Pressure Measurement Section personnel monitor pressure transducer calibration and scanivalve maintenance and installation. Inertial sensor transducer calibration is monitored by personnel from the Dynamic Systems Instrumentation Section. The work of the Wyle group involved in facility instrumentation is monitored by the Instrument Coordination Section. Personnel from the Acoustics and Vibration Instrumentation Section monitor the work of the noise measurement group, and Digital Data Acquisition Section personnel monitor the work of the digital data group. There are approximately 16 engineers and technicians involved, in one form or another, in this monitoring effort.

The contract with Wyle is a Cost Plus Award Fee contract and to a large extent, the amount of fee awarded is determined by the aforementioned monitors. They supply the necessary data (through the Technical Coordinator) to the Award Fee Evaluation Board to make recommendations to the Fee Determination Official (usually the Director for Electronics) to aid in his decision as to the percentage of available fee that will be awarded.

MM&T.--The MM&T contract calls for the installation, repair, calibration, and evaluation of strain and force measuring instrumentation. The primary objective of the contract is the repair and calibration of the approximately 360 force balances in the Langley inventory. In meeting this objective the contractor does an average of 1,500 jobs a year. This involves the installation of about 6,000 strain gages and the calibration of strain gage load cells and mechanical torque wrenches.

Primary monitoring responsibility is delegated to the Force and Strain Instrumentation Section with the Instrument Support Section bearing responsibility for overseeing the load cell calibrations and the maintenance of measurement standards.

Procedures for Having an Instrument Serviced

During any given year, approximately one-third of Langley's instruments will require service. This will include repair, calibration, preventive maintenance, acceptance testing, warranty repair, and factory repair. The focal point for all these services is the Instrument Control Office (figure 1). All instruments requiring service (other than those which for one reason or another, must be serviced in place) are sent by the user to the ICO. Accompanying the instrument will be a work order, Langley form 165 (appendix C). The user checks services desired, procedure(s) to be followed, and known modifications. Space is provided for listing specific symptoms and other remarks. The lower half of the form is used by the servicing technician to list work performed, parts used, and time expended on the instrument. Once service is completed the original is microfilmed and added to the master microfiche for that instrument. Copies of the updated master are forwarded to Wyle and the ICO for filing.

Once the instrument and work order are received at the ICO, technical monitors review all work orders and determine what disposition will be made of the instrument. The monitor's decision is reflected in the appropriate spaces on the work order (government repair, off-base contract repair, on-base contract repair, factory repair, etc.). If the instrument is to be repaired at a contractor's off-base facility (as most are) the work order form also serves as shipping memorandum providing accountability for the instrument.

Once the instrument has been serviced, by whomever, it is returned to the ICO. At this time, representative samples are checked by monitors (either the instrument physically or data sheets) to determine if services have been performed as required. This check forms part of the basis for grading the contractor for award fee evaluation. If an instrument has not

been properly serviced, it is returned for rework, usually resulting in some form of penalty to the contractor. If the instrument is accepted it is returned to the user utilizing the ICO's padded van.

Preventive Maintenance Functions

Due to manpower and funding constraints, preventive maintenance on a routine basis is limited to special cases. Facility digital data systems have preventive maintenance performed on a routine basis and the instruments in the short term and scheduled loan pool are serviced on a regular basis due to the extensive handling these instruments receive in the natural course of being transferred from user to user. Some instruments and instrument systems associated with flight work are serviced on a regular basis. The majority of instruments though, are serviced as needed.

During the third quarter of FY 80 a new mobile instrument verification system was put into service at Langley. This system consists of measuring and generating equipment and has the capability of verifying the operation of a wide range of research instrumentation. This system is taken into a facility on request, normally that of the facility instrument coordinator, and all of the research instrumentation, so far as is practical, in the facility is verified for proper operation. Any items needing repair or complete calibration are sent to the ICO, as any routine job, for service.

The User's Responsibility

While the aforementioned organizations and personnel have the responsibility to provide the instrument user with the best services available, the user has key responsibilities in the system as well. It is the responsibility of the user to assure proper utilization of instruments in his charge. Instruments which sit dormant with no use foreseen or planned should be returned to the ICO for reissue or survey. It is the responsibility of the user to alert IRD when instrumentation in his charge needs service. Only a representative sample (10 percent) of instruments serviced by the contractor are inspected by IRD and occasionally an instrument which does not operate properly is returned to the user. In this event the user should contact IRD as soon as possible. When service is performed in the user's lab area, a service report form (appendix D) is left with the user. The user should complete his portion of the report and forward it to IRD. It is important that this report be completed and forwarded, whether the service was good or bad, since user response is one of the factors used in evaluating contractor performance.

CONCLUSION

The management of a pool of research instruments the size of Langley's is a very complex operation involving over 200 people and a large variety of technical and administrative disciplines. Our repair, maintenance,

calibration, and instrument installation effort is a 100 man-year plus effort. We feel the present system is working well. We are able to keep track of most instruments; instruments in use are calibrated and maintained effectively; and a fair amount of equipment is turned in for reissue. Furthermore, individuals involved are constantly looking for ways to improve service and increase instrument reliability and utilization.

APPENDIX A



MANAGEMENT MANUAL

LANGLEY RESEARCH CENTER

INSTRUCTION 4200.3
PAGE 1 of 3
DATE November 18, 1975

SUBJECT: Property Management - Research Instrumentation

REF: NHB 4200.1, "NASA Equipment Management Manual"

SUMMARY This instruction describes this Center's system for managing the utilization, maintenance, and procurement of research instrumentation.

DEFINITION Research instrumentation is defined as inventoried measuring and control equipment including electronic, electrical, and mechanical devices, and photographic equipment.

POLICY It is the policy of this Center to economically procure, effectively utilize, and adequately maintain and calibrate its research instrumentation.

RESPONSIBILITIES

- | | |
|-------------------------------|---|
| Instrument Research Division | <ul style="list-style-type: none">● Implementing this Center's research instrumentation activities.● Appointing instrument coordinators and instrument consultants. |
| Instrument Control Group, IRD | <ul style="list-style-type: none">● Insuring compliance with the detailed responsibilities for equipment pools as set forth in the reference document.● Managing and operating an instrument pool with inventory for indefinite and scheduled loans.● Coordinating inventory activities with the Property Management Branch, Management Support Division.● Reviewing all instrument procurements to determine pool availability and compatibility with existing equipment.● Coordinating requirements for group (quantity buy) purchases where possible.● Conferring with Instrument Coordinators and Instrument Consultants to maintain proper balance between instruments needed and those on inventory. |

T.S. 782

APPENDIX A

INST. 4200.3
PAGE 2 of 3
DATE November 18, 1975



MANAGEMENT MANUAL

LANGLEY RESEARCH CENTER

*Instrument Coordinators

- Initiating survey action for instruments not on loan, within 30 days of the discovery of their loss, destruction, or damage.
- Advising on proper use of instruments.
- Coordinating efforts to maintain and calibrate instruments.
- Maintaining records and statistics on instruments.
- Arranging and coordinating vendor instrument displays.
- Having new instruments evaluated.
- Working closely with the research facilities to coordinate and implement program measurement requirements.
- Being cognizant of the measurement requirements of the facilities which they coordinate.
- Initiating or reviewing all instrument purchase requests for the facilities which they coordinate.
- Discussing unique facility measurement requirements with instrument consultants.
- Having the accuracy of instruments in their areas verified.
- Advising other coordinators on the availability of instruments in their facilities.
- Coordinating instrument application efforts in their areas.
- Coordinating and expediting the flow of instruments through repair and calibration channels.
- Developing and maintaining overall facility instrumentation plans and records.
- Anticipating facility measurement requirements and taking steps to satisfy these requirements.

*Listed in the Langley Research Center Telephone Directory.

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APPENDIX A



**MANAGEMENT
MANUAL**
LANGLEY RESEARCH CENTER

INSTRUCTION 4200.3
PAGE 3 of 3
DATE November 18, 1975

***Instrument
Consultants**

- Encouraging the return of inactive instruments to the instrument pool.
- Providing advisory assistance in key instrument categories to users and management officials.
- Advising Instrument Coordinators and other personnel on instrumentation in their areas of specialization.
- Establishing standardized specifications for instruments when possible.
- Standardizing on instrument types or models, as practical.
- Reviewing and approving unique instrument purchases in his category.
- Submitting a report to the Director for Electronics, in January of each year, covering his assigned instrument category.
- Initiating training programs as required.
- Advising the Instrument Control Group and Instrument Coordinators on specialized application and calibration procedures when required.
- Approving survey action for instruments in his category.

Loanees

- Initiating survey action on instruments on loan to them within 30 days of the discovery of their loss, damage, or destruction.

RECISION

LMI 4200.3, dated August 14, 1975, T,S, 755.

for Edwin C. Kilgore
Director for Management Operations

*Listed in the Langley Research Center Telephone Directory.

T.S. 782

APPENDIX B

INTRODUCTION

The Langley Research Center instrument pool catalog advises research personnel of the instruments normally available for immediate delivery. This catalog combines all instruments in the Short Term Loan (STL) and Scheduled Loan (SL) programs.

Short Term Loan instruments are loaned for periods up to 20 working days. The Scheduled Loan instruments are loaned for periods up to 90 calendar days. Instruments not immediately available can be reserved and usually made available within several days.

Please use the loan program and time best suited to your needs. There is a limited quantity of instruments assigned to these special loan programs and they are heavily utilized. Because of this extensions are usually not granted. In necessary cases, extension may be granted by calling 2801.

Instruments and loan record cards will be promptly delivered upon request to the Instrument Issue Area (ext. 2801). A "return due date" sticker will be affixed to each instrument indicating the date it should be returned to the ICO. When returning the instrument to the ICO, please call 2801 for transportation.

Supplements to this catalog will be issued as new instruments are added to the pool. Research personnel are encouraged to suggest additional items frequently needed.

For additional technical information call 2801. Please circulate this catalog within your organization and request additional copies as needed.

| Item No. | Descr., Manuf., Model | General Information and/or Specs. |
|----------|-------------------------|--|
| | Accelerometer | 10 mV per g up to 500 g's, power requirement 4 ma constant current |
| | PCB Piezotronics | output impedance less than 100 ohms |
| | 302 M 15 | |
| | Actuator, Relay | Six each single pole double throw relays controlled manually or |
| | HP | remotely from the HP-IB. Contacts rated to 0.5 amps. |
| | 59306-A IEEE | |
| | Adapter, Null Offset | Provides by elec. means the equiv. of a highly accurate and stable |
| | Datametric | ref. pressure for the Barocell sensor. Highly accurate 0.03%, |
| | 1056-A | setability to 1 part in 100,000. |
| | Ammeter | Dc analog type 3 ranges 0-5, 0-20, 0-50 amps. |
| | Weston | |
| | 931 | |
| | Ammeter, Clip-on | Ac-dc current 1-800 amps, checks all ac waveforms including SCR |
| | Pacer Ind. | circuits, reads TRMS ac current, equipped with small recorder, chart |
| | 1800 | speed 1 inch per hr. |
| | Ammeter, Clip-on Milli. | Direct current from 0.02 milliampere to 10 amperes can be measured |
| | HP | without interrupting the current accuracy $\pm 3\%$ of full scale. |
| | 428 B | |
| | Amplifier, dc Diff. | Input impedance - 100 megs. Output impedance less than 0.1 ohms. |
| | Neff | Dual output ± 10 volts at 100 ma. Freq. response less than 3 dB |
| | 122-121 | down at 100 kHz, 1 to 8 channels. |

| Item No. | Descr., Manuf., Model | General Information and/or Specs. |
|----------|------------------------------|---|
| | Amplifier, dc Diff. | Similar to the 122-121 but has a switch selectable filter with |
| | Neff | cutoff freqs. of 10 Hz, 100 Hz, 1 kHz, 10 kHz, and 80 kHz. |
| | 122-123 | |
| | Amplifier, dc Diff. | Similar to 122-123 with operator selected auto range, computer |
| | Neff | controlled range, with analog and/or digital range signals. |
| | 130-302-09 | |
| | Amplifier, Galvo. | Sensitivity with any galvanometer 0.2 to 100 volts/inch. Freq. resp. |
| | Bell-Howell | down less than 3 dB at 10 kHz. Com. mod rej. 10 V at 60 Hz 300 V dc. |
| | 1-171-12 | Input impd. 1 meg. |
| | Analyzer, Balances Vibration | Ac or dc operated dual-channel with two each magnetic mounted pickups |
| | Stewart-Warner | to 10 g acceleration to 100 mils P.P. displacement. |
| | 9000 | |
| | Analyzer, Bus System | Especially useful in design and service work, diagnosis software and |
| | HP | hardware problems. Can drive all bus lines and exercise another |
| | 59401 A IEEE | talker, listener, or controller. |
| | Analyzer, Logic St. | Is a 16 bit but can be expanded to a 32 bit with the use of an |
| | HP | HP 1607 A analyzer. Was designed specifically to debug and trouble- |
| | 1600S | shoot digital equip. |
| | Analyzer, Logic St. | Is basically the same as a 1600S without a CRT but can be used with |
| | HP | most scopes to become an analyzer (except storage scopes). |
| | 1607 A | |

| Item No. | Descr., Manuf., Model | General Information and/or Specs. |
|----------|---------------------------|--|
| | Analyzer, Signal | All digital high speed processing which provides on-line, real time |
| | Saicor | computations-correlation, probability, and enhancement. All modes |
| | SAI-42 | 100 analysis points. |
| | Analyzer, Signal | Same as mod. 42 above except 400 analysis points are computed and |
| | Saicor | both models have analog outputs. |
| | SAI-43A | |
| | Analyzer, Sound-Vibration | 2.5 Hz to 25 kHz, 2 bandwidths 1/3- and 1/10-octave, use direct from |
| | General Radio | microphone or vib. pickup ac or dc operated. |
| | 1564 A | |
| | Analyzer, Spectrum | 10-bit signal quantization, 10 frequency scales 0-50 kHz plus a |
| | Saicor | 0-1 MHz scale, ext. sampling, linear, square, log output. Analog |
| | SAI-52B | output. |
| | Analyzer, Spectrum | 10-bit signal quantization, 10 freq. scales 0-50 kHz, external |
| | Spectral Dynamics | sampling, linear-square-square log, and logarithmic outputs, 10 dB |
| | SD 330 A | calibration markers. |
| | Battery-Pack | For digital thermometers models 2180A and 2190A 12 V dc. |
| | Fluke | |
| | Y2009 | |
| | Borescope | 11-inch light tube |
| | American Cystoscope | |
| | 11 in. | |

APPENDIX D

WYLE LABORATORIES SERVICE REPORT

| | | | | | |
|-------------------------------|---|--------------------|---|-------------------------------|---|
| Inventory or Serial Number | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | Date Received | MO <input type="text"/> DAY <input type="text"/> YR <input type="text"/> | Building Number | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| Manufacture | (Write Out Full Name) | Employee Number | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | Room Number | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |
| Model Number | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | Department | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> | Months Since Last Serviced | <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> |

ELAPSED TIME INDICATOR (ETI) READING WHEN RECEIVED

| | | | | | |
|-------------------|----------------------|--------------------------|-----------|------------------|----------------------|
| A - Not Installed | B - Broken/Replaced | C - Off Scale/Reset | D - Reset | Condition of ETI | <input type="text"/> |
| | E - New Installation | F - Non Resettable Meter | | | 47 |

| | | | | |
|-----------------------|-------------------------|-------------------|-------------------|--|
| 01 - Accept/Verify | 08 - Calib/Adjust/Calib | 15 - Check Out | 21 - Software | Enter Comments Below <input type="text"/> |
| 02 - Digital PM | 09 - Adjust Calibrate | 16 - Set Up | 22 - Process Data | |
| 03 - Repair/Verify | 10 - Calibrate/Accept | 17 - Tear Down | 23 - Overhaul | |
| 04 - Repair/Accept | 11 - Calibrate | 18 - Fab/Install/ | 24 - Other | |
| 05 - Adjust/Verify | 12 - Environmental Test | 19 - Design | | Service Required |
| 06 - Modify/Verify | 13 - Fabricate | 20 - Document | | |
| 07 - Repair/Calibrate | 14 - Install/Check | | | |

| | | | |
|---------------------------|---------------------------|--------------|----------------------------------|
| A - In Specification | D - 1.5 - 2.0 Times Spec. | M - Modified | Condition When Received |
| B - Adjusted In Spec. | E - X2.0 Times Spec. | R - Repair | |
| C - 1.0 - 1.5 Times Spec. | F - Adjusted First | Z - Other | |
| 1 - Exceeds Spec. | 5 - Broken | 9 - Other | Condition of Part Replaced |
| 2 - Open | 6 - Bent | | |
| 3 - Shorted | 7 - Corroded | | |
| 4 - Leaky | 8 - Overheated | | |

| | | | |
|-------------------|-------------------|------------------|-----------------------|
| Electrical | Mechanical | X - Other | Type Part Replaced |
| A - Resistor | M - Belt | | |
| B - Capacitor | N - Motor | | |
| C - Lamp | O - Gear | | |
| D - Ind/Xfmr | P - Shaft | | |
| E - Diode | Q - Bearing | | |
| | R - Spring | | |
| | S - Fastener | | |
| | T - Fitting | | |
| | U - Valve | | |
| | V - Seal | | |
| | W - Fluid | | |

| | | | | |
|----------------|--------------------|----------------|-----------|-------------------|
| A - Wyle Stock | B - Purchase Order | C - NASA Stock | D - Other | Source of Part |
| | | | | |

| | | | | |
|-----------------|----------------------|---------------------|-----------|------------|
| 01 - LL MUX | 08 - Memory | 15 - Servo Lock | 22 - ADC | 26 - Other |
| 02 - HL MUX | 09 - IBM Punches | 16 - IBM Tabulators | 23 - DAC | |
| 03 - Tape | 10 - Teletype | 17 - Programmers | 24 - CRT | |
| 04 - Relay | 11 - Card Reader | 18 - Time Code Gen. | 25 - Plot | |
| 05 - Encoder | 12 - Control Logic | 19 - CPU | | |
| 06 - Printer | 13 - Control Circuit | 20 - DVM | | |
| 07 - Calibrator | 14 - Power Supply | 21 - I/O | | |

| | | | | |
|---------------------------|-----------------------|----------------------|-----------|-------------|
| A - Returned in Spec. | D - Job Cancelled | G - Factory Warranty | Z - Other | Disposition |
| B - Found No Problem | E - Failed Acceptance | S - Recommend Survey | | |
| C - Returned Out of Spec. | F - Factory Repair | W - Sent To Wyle | | |

| | | | | | |
|-----------|--|-----------------|---------------------|-------------|----------------|
| Completed | MO <input type="text"/> DAY <input type="text"/> YR <input type="text"/> | Repair Hours | Calibrated Hours | Material \$ | Other Hours |
| | 66 67 68 69 70 | 71 72 | 73 74 | 75 76 77 | 78 79 80 |

WYLE
COMMENTS

USER'S
COMMENTS
ON
SERVICE

Were you able to contact Wyle easily?
Did Wyle respond in a timely manner?
Was Wyle's technical proficiency acceptable?
Was the job quality satisfactory?

- AVG. +

Monitor
Scoring

Total

NASA User Comments

Signed ;

(NASA User)

W 623-1 SERVICE REPORT FORM

(See Reverse Side For Instructions)

N-786

APPENDIX D

INSTRUCTIONS FOR COMPLETION OF THE FIELD SERVICE REPORT FORM

WYLE TECHNICIAN

- Spaces 1-7 Inventory or serial number. Use the NASA inventory number when available. The basic inventory number should be written in spaces 1-6. If the basic inventory number contains a dash number, place it in space 7. *If there is no inventory number, use the serial number and prefix it with an S in space 1. If the s/n has more than six digits, begin with the least significant digit in space six. Fill in all of the spaces.*
- Spaces 8-12 Write in the manufacturer's full name unless abbreviations are well known, such as HP or TEK.
- Spaces 12-19 If the model number contains too many digits, place the least significant digit in space 19 and work left.
- Spaces 42-46 The time must be right oriented and be in hours - drop all tenths.
- Spaces 53-58 When parts are replaced, estimated material cost shall be entered in spaces 75-77.

-----F-O-L-D--O-N--D-O-T-T-E-D--L-I-N-E-----

- Spaces 62-64 When an ADP or system number appears in these spaces, it is mandatory that an elapse time reading be entered in spaces 42-46.
- Spaces 66-70 The completion date shall be filled in; the computer program places the F/S Report in chronological order by the completion date.
- Check the appropriate monitor's box for mailing.
- Give a copy of the form to the NASA user for comments and transmittal to the NASA monitor.

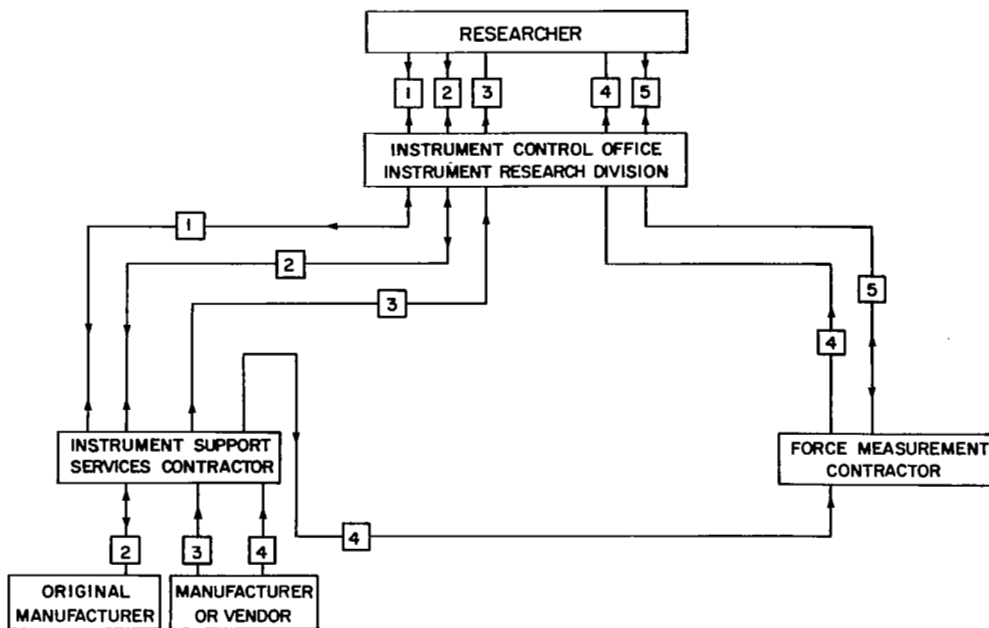
NASA USER

1. Review the form and make comments if desired.
2. Check the appropriate box under "- AVG +".
3. Fold along the dotted line and mail to the NASA monitor checked below:

-----F-O-L-D--O-N--D-O-T-T-E-D--L-I-N-E-----

Mail to:

- | | | |
|--------------------------|------------------|--------------------------------|
| <input type="checkbox"/> | E. German | Mail Stop 236 (IRD Bldg. 1230) |
| <input type="checkbox"/> | William E. Fox | Mail Stop 236 (IRD Bldg. 1230) |
| <input type="checkbox"/> | L. Wesley Machen | Mail Stop 238 (IRD Bldg. 1230) |



1. Instruments requiring routine maintenance and/or calibration
2. Instruments requiring specialized factory repair and/or calibration
3. New instruments (other than force measurement)
4. New force measurement equipment
5. Force measurement equipment requiring routine maintenance and/or calibration

FIGURE 1- ROUTING OF LRC INSTRUMENTATION REQUIRING SERVICE

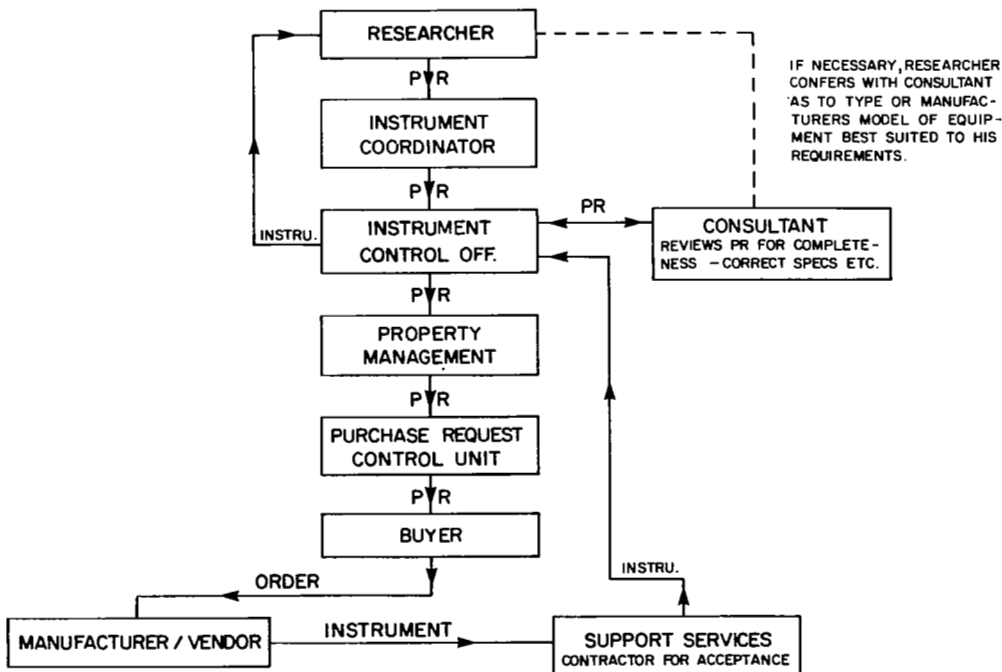
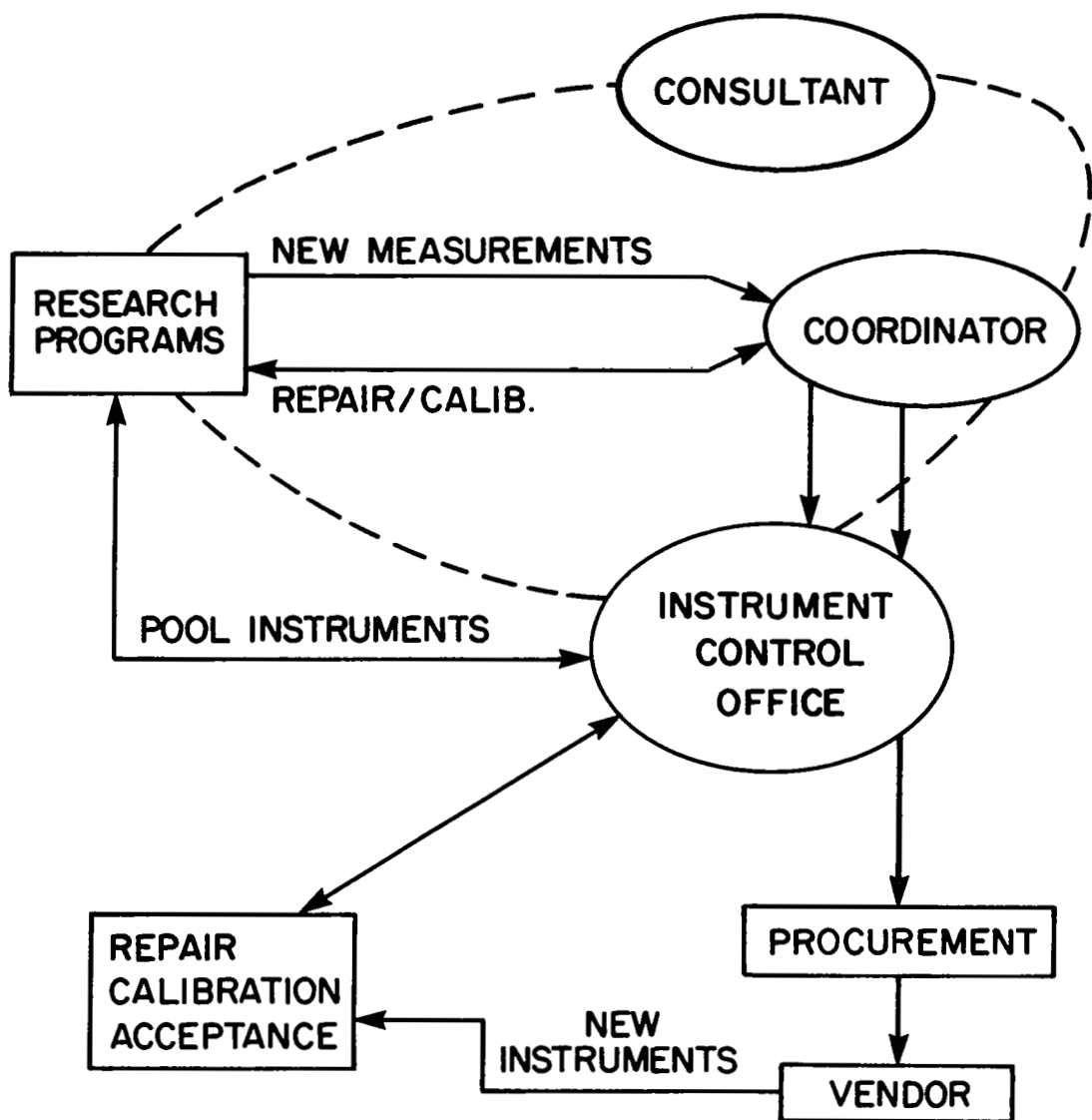
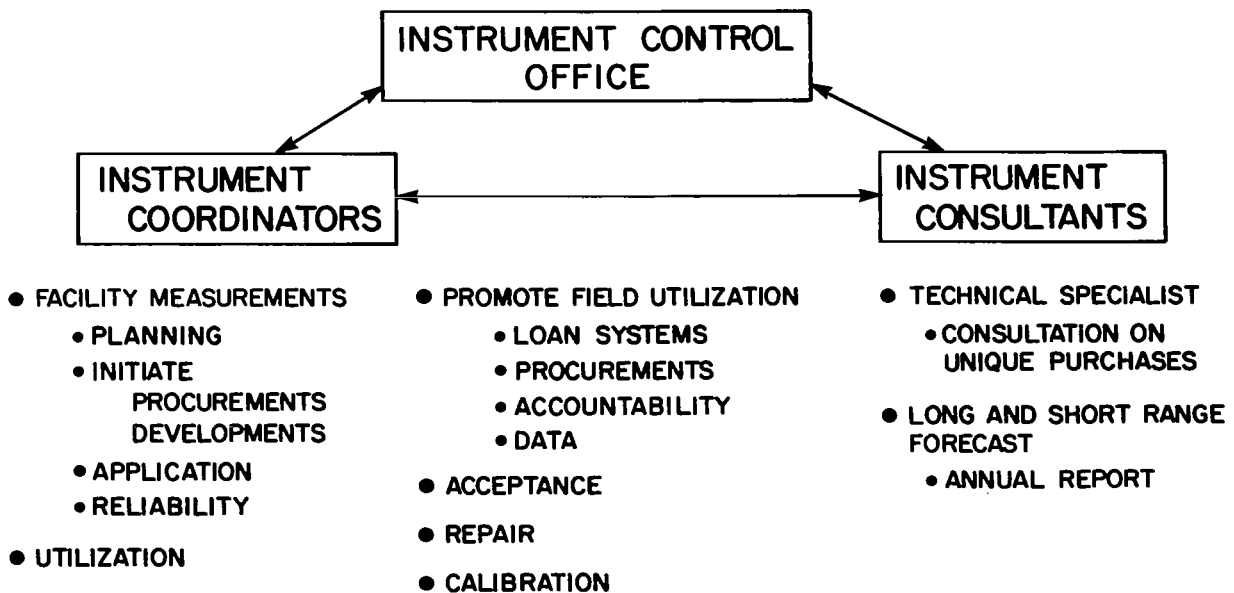


FIGURE 2 - ROUTE OF PURCHASE REQUEST FOR A TYPICAL INSTRUMENT AND SUBSEQUENTLY PROCURED INSTRUMENT (SIMPLIFIED - DOES NOT INCLUDE BIDS, SECTION, BRANCH, DIVISION REVIEW ETC. IF REQUIRED)



- ~ 100 RESEARCH FACILITIES
- ~ 35000 INSTRUMENTS
- ~ \$81 MILLION
- ~ 20000 CONTROLLED

- **INSTRUMENT CONTROL OFFICE**
INSTRUMENT POOL
- **INSTRUMENT COORDINATORS**
- **INSTRUMENT CONSULTANTS**
- **INSTRUMENT SERVICE**



INSTRUMENT POOL

- INDEFINITE LOAN
- SCHEDULED LOAN
- SHORT TERM LOAN

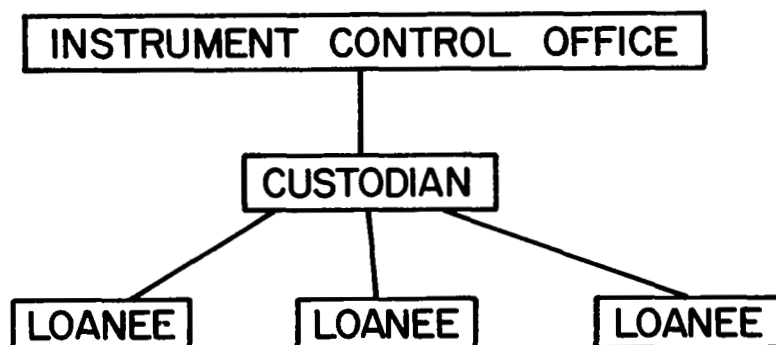
SHORT TERM - SCHEDULED LOANS

~ 1200 INSTRUMENTS

SHORT TERM LOAN
20 WORK DAYS

SCHEDULED LOAN
90 CALENDAR DAYS

~ 3600 LOANS / YEAR



REPRESENTATIVE SHORT-TERM/SCHEDULED LOAN INSTRUMENTS

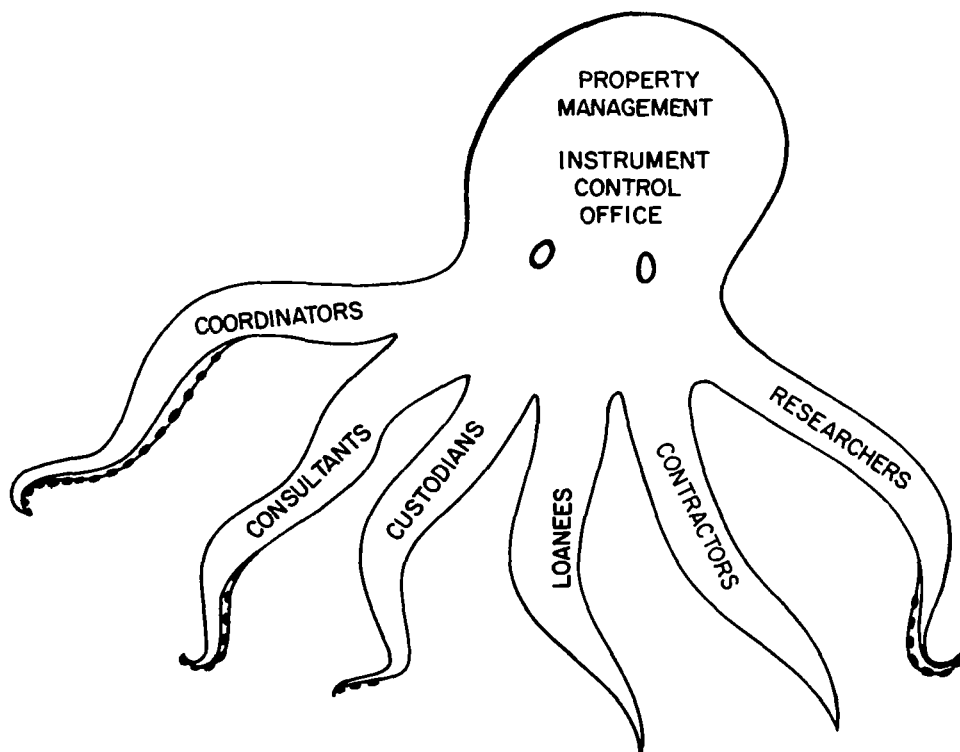
- STOPWATCH
- CAPACITOR METER
- POLAROID CAMERA
- ACOUSTIC COUPLER
- DIAL GAGES
- SURFACE PYROMETER
- CASSETTE RECORDER
- FREQUENCY COUNTER
- STRIP CHART RECORDER
- COUNTER PLUG-IN
- AIR METER
- AMMETER
- WHEATSTONE BRIDGE
- TEMPERATURE RECORDER
- TEMPERATURE CONTROLLER
- D-A CONVERTER
- LEAK DETECTOR
- ELECTRO-LEVEL
- BANDPASS FILTER
- HYGROMETER
- IMPEDANCE METER
- MECH. INTEGRATOR
- INVERTER
- LCR METER
- DVM
- DMM
- POWER SUPPLY
- OVERHEAD PROJECTOR
- SLIDE PROJECTOR
- RADIOMETER
- X-Y RECORDER
- ICE POINT STD.
- STROBOTACH
- DIG. TACHOMETER
- ANALOG TACHOMETER
- THERMOMETER
- SCOPE CAMERA
- GAUSSMETER
- LOAD KIT
- OSCILLOSCOPE
- SCOPE PLUG-IN
- STD. MAGNET
- TUBE TESTER
- CHARGE AMPLIFIER
- AMPLIFIER
- VIBRATION ANALYZER
- SPECTRUM ANALYZER
- DECADE RESISTOR
- LINE CONDITIONER
- MICROPHONE
- PHASE METER
- SIGNAL GENERATOR
- MILLIVOLT STD.
- VOLTAGE STD.
- TIME CODE GENERATOR
- WATT METER
- MANOMETER
- VAVUUM GAGE
- PRESSURE TRANSDUCER
- DECADE CAPACITOR

INSTRUMENT SERVICE

- 2 SUPPORT SERVICES CONTRACTORS
- ~1,500 FORCE BALANCE CALIBRATIONS / YEAR
- ~16,000 REPAIR/CALIBRATION ACTIONS/ YEAR (OFF SITE)
- ~5000 ON-SITE SERVICE CALLS

CONSULTANT CATEGORIES

- ACOUSTIC
- AMPLIFIERS
- BALANCES
- CAMERAS
- DIGITAL DATA SYSTEMS
- DIGITAL VOLTMETERS
- FREQUENCY COUNTERS
- FACILITY WIRING
- FLOWMETERS
- HIGH-SPEED PHOTOGRAPHY
- LASER DEVICES
- OPTICS, MIRRORS, FLOW
VISUALIZATION
- LOAD CELLS
- ACCELEROMETERS
- MAGNETIC TAPE RECORDERS
- MANOMETERS, PRESSURE VACUUM
GAGES (>1 MICRONS)
- OSCILLOGRAPHS, GALVANOMETERS
- OSCILLOSCOPES
- POWER SUPPLIES
- PRESSURE TRANSDUCERS
- SELF-BALANCING POTENTIOMETERS, PEN.
RECORDERS
- SPECTROSCOPY
- THERMAL
- TV SYSTEMS



THE LANGLEY RESEARCH CENTER MOBILE PREVENTATIVE MAINTENANCE SYSTEM

Mallory S. James
Langley Research Center

Instrument Research Division
Instrument Support Section

INTRODUCTION

To verify more efficiently, and on a more regular schedule, that electronic instruments being used in Langley Research Center facilities are operating within required specifications, whether they are manufacturers', procurement or some special specifications, a group of working standards and other necessary instruments have been assembled on mobile lightweight carts. The system is transported to the facilities by van and the facility's instruments are tested, when possible, in place. When work space is not available in the laboratory where the instruments to be tested are located, the system is positioned in a nearby laboratory and the instruments are brought there for testing. No repairs are made and adjustments are made only when the adjustment controls are readily accessible with only the cover removed, or front panel adjustments are available for rack mounted instruments. Instruments which cannot be brought within specifications are tagged with a recommendation that the user send it to the Instrument Research Division for service. The system provides increased service to facilities and provides them with more instruments within specifications, which improves confidence in the accuracy of the data they obtain. The system also provides the service while eliminating the cost of transporting the instruments to and from the service facility, and the additional paperwork required when that mode of service is used. The mode of service entails: 1) The user removes the instrument from his system and fills out a work order and shipping tag; 2) a transportation contractor transports it to the Instrument Research Division (IRD); 3) the NASA service contract monitor assigns the instrument to the proper group at the service facility and a date the instrument should be returned; 4) the service contractor picks up the instrument and work order from IRD and transports them to the service facility; 5) the service contractor processes the work order and instrument to the proper group in their facility; 6) when the service is completed on the instrument it is returned to the user through the reverse of the above procedure. Time is also saved by having all of the equipment required to test most types of instruments, assembled together, rather than have a technician gather the necessary different test equipment required to test different types of instruments.

DESCRIPTION OF SYSTEM

The system is composed of twelve instruments, many of which have multi-capabilities, on two scope carts with shelves and one rolling table, which also provides work space. They are light enough to be hand-lifted into a van for transporting to the facilities. The instruments are:

- Tektronix SC504 Oscilloscope
- Tektronix DM502 DMM
- Tektronix GS504 Signal Generator
- Wavetek 3000 AM-FM Signal Generator
- Tektronix 7623A Oscilloscope main frame with:
 - 7A13 Differential Comparator Vertical Plug-in
 - 7A26 Dual Trace Vertical Plug-in
 - 7B53A Time Base Plug-in
- Tektronix TG501 Time Mark Generator
- Tektronix PG506 Calibration Generator
- Tektronix SG503 Signal Generator
- Tektronix DC505A Counter
- Tektronix FG504 Function Generator
- Hewlett Packard 339A Distortion Analyzer
- Fluke 5101B Calibrator with Printer, IEEE interface

With this system the following types of instruments can be tested:

| | |
|----------------------|-----------------------|
| DVM's | Frequency converters |
| DMM's | Discriminators |
| Oscilloscopes | Filters |
| Counters | Amplifiers |
| Spectrum analyzers | Signal generators |
| Distortion analyzers | Strip chart recorders |
| Receivers | Oscillographs |
| AC & DC voltmeters | Power supplies |

At the present time, DVM's and DMM's with a resolution of less than $4\frac{1}{2}$ digits are verified, in place, and those with greater accuracy and resolution, if they are overdue of calibration, are tagged to go to the service facility.

It should be noted that because of manpower limitations, this mobile service is provided to instrument users, when time is available, between emergency repair jobs performed by the service contractor's field service group.

Preliminary results using the system indicate that the system should be expanded to include more precise and automated equipment that could be controlled by an HP 9835 calculator or a Fluke 1720 controller allowing a print-out of calibrations to be supplied to instrument users.

RESULTS

During the first six months of operation 644 instruments were tested in seven different facilities. The average time required to test an instrument was two hours. This is a savings of from 2 to 2½ hours per instrument when compared to sending the instrument to the service facility for preventative maintenance. This is especially true when time is added in to transport each instrument to and from the service facility and time for additional paperwork. Also considerable overhead costs are avoided. At the present rate of progress the system should pay for itself in about a year and after that a cost avoidance of from \$35,000 to \$40,000 per year should be realized. Another advantage is that an instrument is out of service for only two hours rather than two weeks on the average.

CONCLUDING REMARKS

In conclusion, the system is very compact and of a reasonable weight for ease of transporting. It contains instruments that can verify the condition of most of the electronic instrumentation at LRC. In its present configuration, it is very cost effective and should be even more so when automation capabilities are added.



GODDARD SPACE FLIGHT CENTER'S AUTOMATED CALIBRATION SYSTEM

Walter L. Owens
Goddard Space Flight Center

The Automated Calibration System (ACS) developed at Goddard Space Flight Center is a transportable system to be used for in-situ calibration of test instruments. It was put into operation in July 1980. The ACS updates and will soon replace the very successful manually operated Assured Performance Calibration (APC) system that has been in operation for about 14 years.

Transportability of the new Automated Calibration System provides significant advantages over out-of-service calibration. Most importantly, the instruments can be calibrated in the users' laboratories by moving the calibration system into the laboratory or a convenient location near several laboratories. During calibration, adjustments are made to bring the instruments within specifications whenever practical to do so, i.e., if adjustment points are accessible without removing instruments from racks or if disassembly is not necessary. Some minor repairs are also performed. If major adjustments or repairs are required, the instruments are tagged and the user later sends them to the Test Equipment Maintenance and Repair Laboratory for service. This in-situ calibration returns the instrument to use in a much shorter time than out-of-service calibration.

The heart of the new Automated Calibration System is a calculator-controller using the IEEE-488 interface bus. Other instruments in this system are interface bus compatible and include: thermal printer, digital multimeter, RLC bridge, voltage-current-resistance calibrator, frequency counter, frequency generators, Rf power meter, modulation analyzer, frequency attenuators and switches, and necessary accessory items. These instruments provide calibration capabilities for voltage, current, resistance, capacitance, inductance, frequency, Rf power, and AM/FM phase modulation. Table 1 lists the ACS capabilities in the categories of Source and Measurement. (Calibration capabilities for oscilloscopes and power supplies will be added in the near future.) The interface bus permits the ACS to be easily expanded for future calibration needs. Instruments in the Automated Calibration System are housed in a transportable cabinet equipped with four shock absorbing wheels. See figure 1.

Calibration with the new ACS requires calculator-controller programs to be written for the wide variety of instruments located in users' laboratories. At the present time approximately 100 programs have been written and others are being written as necessary to include as many instruments as practical in the Automated Calibration System. The programs

use BASIC language and they are written by the technicians doing the calibration. This permits the programs to be tailored to specific instruments by the persons directly involved in the ACS operation.

There are several advantages to using the ACS approach: the calibration instruments are operated and controlled through the calculator-controller, operator error is reduced, operator training is reduced, more uniform calibrations are made, and more data points are taken. The more uniform calibrations result from the use of approved programs with the calculator-controller which require the operators to follow each step of the procedure. The data points are tabulated by the thermal printer to provide hard copy documentation of the calibration results. This documentation is provided to the instrument user and another copy is generated for use by the calibration and repair facility. This latter copy is used to identify problem instruments, characterize instrument performance trends, and aid in the diagnosis of necessary repairs.

The Automated Calibration System has been in operation for less than two months and cannot be meaningfully evaluated. However, most of the reactions of the instrument users have been favorable toward the ACS. One very favorable reaction is that the users are more likely to send the ACS rejected instruments to the laboratory for service than they were when the older system was in use. This is primarily due to the documented results indicating why an instrument was rejected. Evaluation of the ACS by the operators and other interested people indicates a vast improvement of in-situ calibrations, i.e. more accurate, more consistent, and more thorough calibrations. In addition a wider variety of instruments are being serviced than was previously possible. The in-situ calibrations with the ACS provide more valuable services to the instrument users than the previous system. It is anticipated that more improvements in the service will be obvious as more experience is obtained using the ACS. The new Automated Calibration System is proving to be a very valuable system and it will be expanded as necessary to satisfy the growing calibration needs at the Goddard Space Flight Center.

TABLE 1A: GODDARD SPACE FLIGHT CENTER'S AUTOMATED CALIBRATION SYSTEM CAPABILITIES

| <u>SOURCE</u> | <u>RANGE</u> | <u>UNCERTAINTIES</u> |
|---------------------|---|---|
| D. C. VOLTAGE | 100 μ V to 1100 V | \pm (.005% of output + .001% of range + 5 μ V) |
| DIRECT CURRENT | 10 μ A to 2 A | \pm (.025% of output + .0025% of range + .01 μ A) |
| A. C. VOLTAGE | 1 mV to 1100 V | 50 Hz to 10 kHz \pm (.05% of output + .005% of range + 50 μ V) |
| | 1 mV to 20 V 50 Hz to 50 kHz | 10 kHz to 50 kHz \pm (.08% of output + .008% of range + 50 μ V) |
| | Wide band option, 300 μ V to 3V at 10 Hz to 10 MHz | \pm (2% output to .25% range) to \pm (0.25% output + 0.25% range) |
| ALTERNATING CURRENT | 10 μ A to 2A 50 Hz to 1 kHz | \pm (.07% of output + .01% of range + 2 μ A) |
| RESISTANCE | 1 Ω to 10 k Ω (4 terminal) | 1 Ω \pm .02% 10 Ω \pm .01% 100 Ω , 1 k Ω , 10 k Ω \pm .005% |
| | 100 k Ω to 10 M Ω (2 terminal) | 100 k Ω \pm .005% 1 M Ω \pm .01% 10 M Ω \pm .05% |
| FREQUENCY | 1 μ Hz to 20 MHz sine wave Auxiliary output, 21 MHz to 61 MHz sine wave 10 MHz to 1 GHz | \pm 5 x 10 ⁻⁶ of selected value \pm 2% |
| FREQUENCY REFERENCE | 10 MHz | Stability (aging rate) <5x10 ⁻¹⁰ /day (short term) <1x10 ⁻¹¹ for 1 second average time |

TABLE 1B: GODDARD SPACE FLIGHT CENTER'S AUTOMATED CALIBRATION SYSTEM CAPABILITIES

| <u>MEASUREMENT</u> | <u>RANGE</u> | <u>UNCERTAINTIES</u> |
|----------------------------|--|---|
| INDUCTANCE | 0.2 μ H to 2000 H | \pm 0.1% of reading |
| CAPACITANCE | 0.2 pF to 2000 μ F | \pm 0.1% of reading |
| RESISTANCE | 2 m Ω to 2 M Ω | \pm 0.1% of reading |
| | 1 m Ω to 15 M Ω | 0.1 k Ω range \pm (0.005% of reading + .006% of range) 10,000 k Ω range \pm (0.1% of reading + .006% of range) |
| D.C. VOLTAGE | 1 μ V to 1,000 V | \pm (0.01% of reading + .001% of range) |
| A.C. VOLTAGE | 10 μ V to 1,000 V true RMS 30 Hz to 1 MHz | 30 Hz to 20 kHz \pm (.06% of reading + .06% of range) 500 kHz to 1 MHz \pm (6.3% of reading + 2.4% of range) |
| FREQUENCY | 10 Hz to 18 GHz | Stability (aging rate) $<5 \times 10^{-10}$ /day (short term) $<1 \times 10^{-11}$ for 1 second average time |
| | D.C. to 125 MHz | Same as above |
| POWER (RADIO FREQUENCY) | -30 dBm to +20 dBm (1 μ W to 100 mW) 100 kHz to 18 GHz | $<3.3\%$ 100 kHz to 6 GHz $<6.3\%$ 6 GHz to 18 GHz |

TABLE 1B: GODDARD SPACE FLIGHT CENTER'S AUTOMATED CALIBRATION SYSTEM CAPABILITIES

| <u>MEASUREMENT</u> | <u>RANGE</u> | <u>UNCERTAINTIES</u> |
|--------------------|---|--|
| MODULATION | 150 kHz to 1300 MHz | Resolution: 10 Hz below 1000 MHz 100 Hz above 1000 MHz |
| AMPLITUDE | Rates: 20 Hz to 100 kHz Depths: to 99% | $\pm 1\%$ of reading ± 1 digit for rates 50 Hz to 50 kHz and depths $> 5\%$ |
| FREQUENCY | Rates: 20 Hz to 200 kHz Deviations: to 400 kHz | $\pm 1\%$ of reading ± 1 digit for rates 30 Hz to 100 kHz |
| PHASE | Rates: 200 Hz to 20 kHz Deviations: to 400 radians | $\pm 3\%$ of reading ± 1 digit |

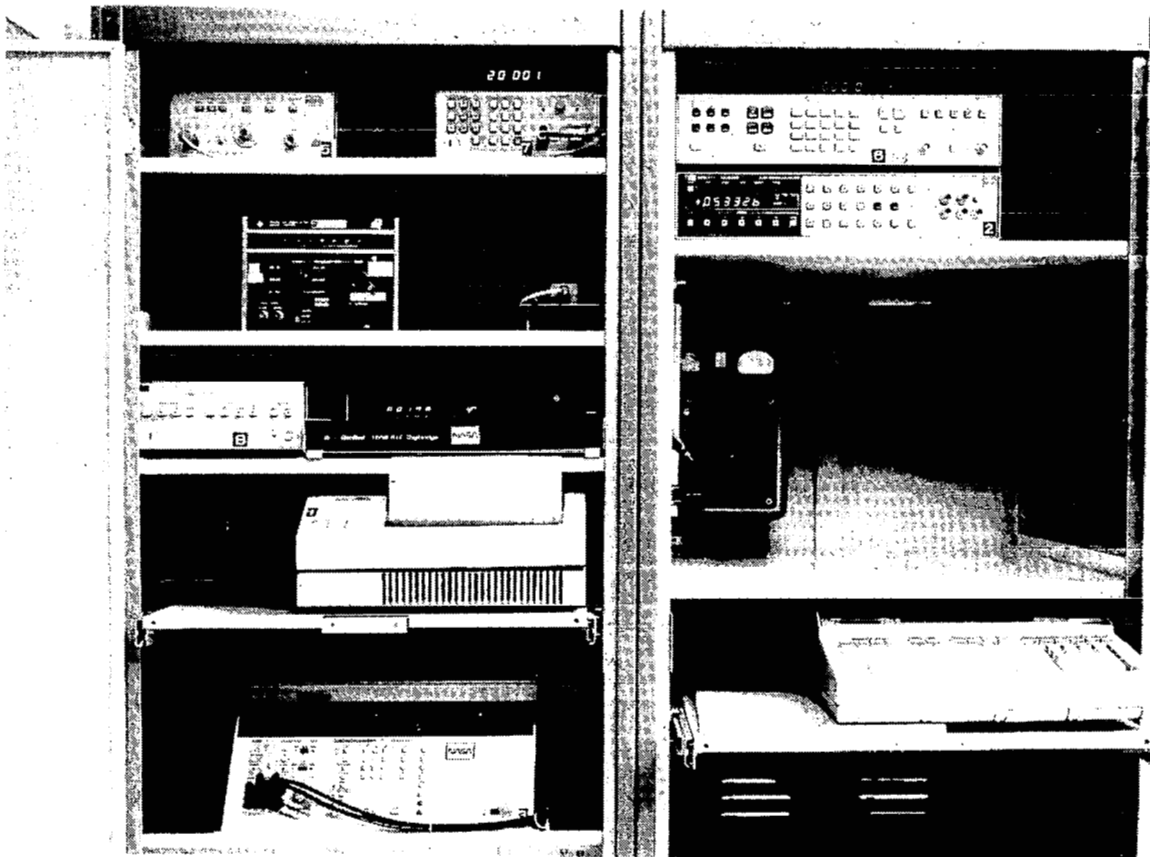


Figure 1.- Goddard Space Flight Center Automated Calibration System.

CALIBRATION INTERVALS
FOR
NASA REFERENCE STANDARDS

CALIBRATION INTERVAL - VOLT

| <u>CENTER</u> | <u>MFG</u> | <u>MODEL</u> | <u>INTERVAL MONTHS</u> | <u>NBS</u> | <u>MAP</u> | <u>OTHER</u> |
|---------------|-------------|--------------|----------------------------|------------|------------|--------------|
| WSTF | Guildline | 9152/12 | 12 | X | X | |
| WFC | Biddle-Grey | 608000 | 60 | | | X |
| MSFC | Epply | M-106-3 | 12 | | | X |
| NSTL | Guildline | 9152/P4 | 12 | X | | |
| DFRC | Epply | 101 | 24 | X | X | |
| LeRC | Epply | 106 | 24 | X | | |
| JSC | GUF | 9154D | 24 | X | X | |
| JPL | Guildline | 9154C | | | X | |
| KSC | Epply | 114/105 | 18 | X | X | |
| GSFC | Guildline | 9152/P4 | 24 | X | | |
| | | 9152/12 | 24 | X | | |
| LaRC | Guildline | 9152/6S | 24 | X | X | |

CALIBRATION INTERVAL - PRESSURE

| <u>CENTER</u> | <u>MFG</u> | <u>MODEL</u> | <u>INTERVAL MONTHS</u> | <u>NBS</u> | <u>MAP</u> | <u>OTHER</u> |
|---------------|------------|--------------|----------------------------|------------|------------|--------------|
| LSTF | Ruska | 2465 | 24 | X | | |
| WFC | B&H | 6-201 | 36 | | | X |
| MSFC | Ruska | 2450 | 12 | X | | X |
| NSTL | Ruska | 2465 | 12 | | | X |
| DFRC | B&H | 6-201 | 24 | | | X |
| LeRC | Ruska | 2460 | 48 | X | | |
| JSC | Ruska | 2460 | 120 | X | | X |
| KSC | Ruska | 2460 | 48 | X | | X |
| GSFC | Ruska | 2465 | 60 | X | | |
| LaRC | B&H | 6-201 | 60 | X | | |

| | | | | | |
|---|--|-----------------------------|---|---|--|
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| 12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546 | | | | 14. Sponsoring Agency Code | |
| | | | | | |
| 15. Supplementary Notes This NASA Metrology and Calibration Workshop (Fourth Annual) is the first to be documented by a NASA Conference Publication. | | | | | |
| 16. Abstract The proceedings of the Fourth Annual NASA Metrology and Calibration Workshop are presented. This workshop covered (1) review and assessment of NASA metrology and calibration activities by NASA Headquarters, (2) results of audits by the Office of Inspector General, (3) review of a proposed NASA Equipment Management System (NEMS), (4) current and planned field center activities, (5) National Bureau of Standards (NBS) calibration services for NASA, (6) review of NBS's Precision Measurement and Test Equipment (PMTE) Project activities, (7) NASA instrument loan pool operations at two centers, (8) mobile cart calibration systems at two centers, (9) calibration intervals and decals, (10) NASA Calibration Capabilities Catalog, and (11) development of plans and objectives for FY 1981. Several papers in this proceedings are slide presentations only. | | | | | |
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